UNITED STATES MARINE CORPS
COMBAT ENGINEER INSTRUCTION COMPANY
MARINE CORPS ENGINEER SCHOOL
PSC BOX 20069
CAMP LEJEUNE, NORTH CAROLINA 28542-0069

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31 Jan 00
(00 POI)

STUDENT HANDOUT

WOOD FRAME CONSTRUCTION

1. **Purpose:** This period of instruction is to provide you with the knowledge necessary to build a wood frame construction.

2. **Learning Objectives**

a. Terminal Learning Objective(s):

(1) Provided a mission, construction site, engineer carpentry tools, portable power tools, power source, lumber, specifications, and references, cut lumber to meet mission specific dimensions, utilizing proper tools while observing safety precautions per the references. (1371.01.01)

(2) Provided a mission, construction site, specifications, engineer carpentry tools, lumber cut to specification, nails, and references, place lumber to meet mission specifications, utilizing proper tools while observing safety precautions per the references. (1371.01.02)

b. Enabling Learning Objective(s):

(1) Given a requirement to cut lumber, a list of dimensional lumber and a list of grade specifications, select lumber that is appropriate for the requirement per the references. (1371.01.01a)

(2) Given a construction mission and a list of carpentry tools, select the appropriate measuring tools to lay out a measurement per the references. (1371.01.01b)

(3) Given a specified length, lumber, measuring tools and marking tools, lay out the measurement on the lumber to the specified length per the references (1371.01.01c)

(4) Given the requirement to cut lumber, a list of portable and non-portable power tools, and a list of engineer hand tools, select the proper cutting tools to cut the lumber per the references (1371.01.02d)

(5) Given a previously measured piece of lumber, cutting tools, and safety devices, cut lumber to dimension per the references (1371.01.01e)

(6) Given a requirement to cut lumber, a list of safety equipment, and safety regulations, select appropriate safety measures per the references. (1371.01.01f)

(7) Given a list of engineer tools, state the procedures to maintain the tools per the references. (1371.01.01g)

(8) Given a requirement to place lumber and a list of fasteners, select the proper fastener per the references. (1371.01.02a)

(9) Given a requirement to place lumber, a type of fastener, and a list of fastening tools, select the proper fastening tool based on the type of fastener required per the references. (1371.01.02b)

(10) Given a requirement to place lumber and a list of possible connections, select the best connection per the references. (1371.01.02c)

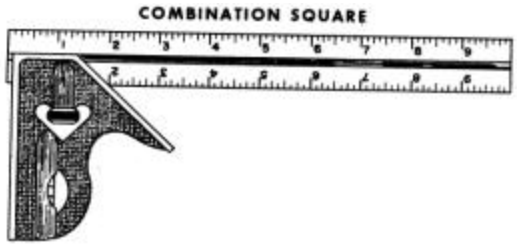
(11) Given a list of wood frame structure components, and pictures or drawings of wood frame structure components, match each component to its picture or drawing per the references. (1371.01.02d)

(12) Given a requirement to construct a wood frame structure, lumber cut to dimension, fasteners, engineer tools and safety devices, place lumber for appropriate components per the references. (1371.01.02e)

OUTLINE

1. LAYOUT, MEASURING, AND LEVELING TOOLS

   a. Combination Square

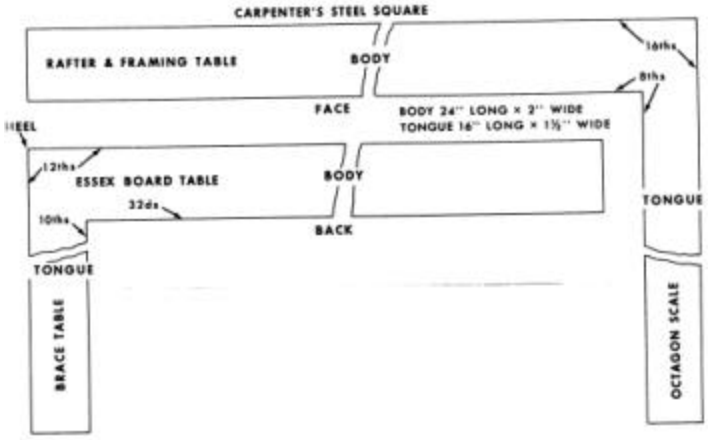


(1) Description. The combination square is a steel blade, 12 inches long, grooved along its entire length on one side and fitted to a metal head that can be clamped at any position along the blade using the clamping screw. The blade is graduated in sixteenths of an inch. The head has machined edges at 90 degree and 45 degree angles to the blade. It is fitted with one leveling vial, and a steel scribe (scratch awl) is set into the head

(2) Uses. The combination square can be used as a try square, for checking 45-degree angles, to test for plumb or level, as a depth gauge, or as a marking gauge.

(3) Maintenance and Care. The combination square is a precise instrument. Lay it down gently when finished using it. Keep the blade lightly oiled to prevent rust.

b. Carpenter's Square



(1) Description. The carpenter's square consists of two arms set at exact right angles to each other. The larger arm, which is 24 inches long, is called the "blade". The smaller arm, called the tongue" is 16 inches. The angle or junction between the arms is called the "heel", whether it is inside or outside the angle remains 90 degrees.

(2) There are five tables on the square.

(a) The Essex Board Measuring Table is on the back of the blade. It is used to quickly compute board feet in solid lumber that comes in standard sizes.

(b) The Brace Measure Table is along the back of the tongue. This table gives the lengths of commonly used braces.

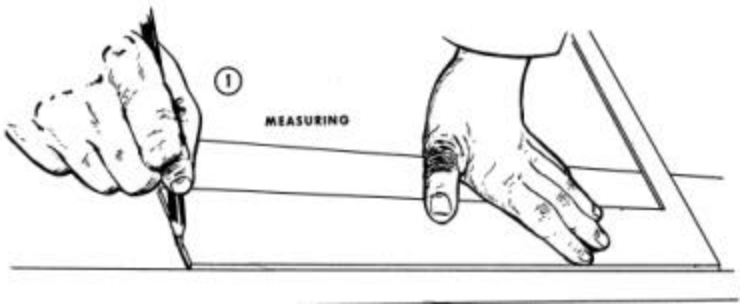
(c) The Rafter Table is along the face of the blade. On some squares a second rafter table is also found on the back of the blade. This table is used to determine rafter lengths, slopes, and overhangs.

(d) The Hundredth Scale is located on the tongue near the heel, on the back of the square. It can be used to obtain fractions or decimals of an inch.

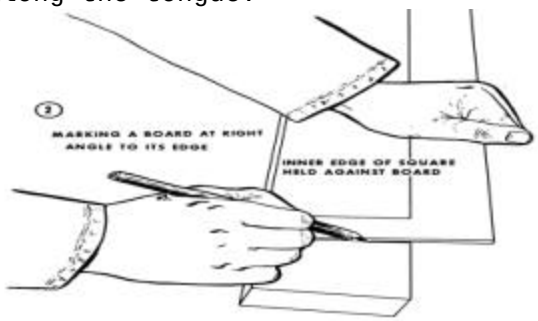
(e) The Octagon Scale is on the face of the tongue and is used to lay off lines when it is necessary to cut an octagon shape from a square piece of lumber.

(3) Uses. There are so many uses for the carpenter's square that entire books have been written on the subject. A few of the uses are listed below.

(a) To measure the length of a board, place the blade on the board with the heel at one end, and mark where the other end is with a sharp tool. This will be 24 inches. Place the heel at this mark and continue measuring in the same manner until you have reached the end of the board.



(b) To mark across a board, place the edge of the blade along the edge of the board. The tongue will now be at right angles to the edge of the board. Make your mark along the tongue.



(c) To test for squareness, place the edge of the blade along the board, with the edge of the tongue at the end of the board. The edge of the tongue should exactly match the end of the board with no light showing through.

(4) Maintenance and Care. Clean the square with a light abrasive and keep it lightly oiled

c. Try Square

(1) Description. The try square is a steel blade eight inches long, graduated in eighth inch increments and set into a wooden or metal handle. The handle is called the "beam".

(2) Uses. The try square is used for marking lines at right angles, to test surfaces or edges for consistent thickness throughout their lengths, and to test for straightness. To test for straightness, place the handle against

the edge of the board with the inside of the edge of the blade against the edge to be tested. You should not see space or light between the blade and the cut being tested.

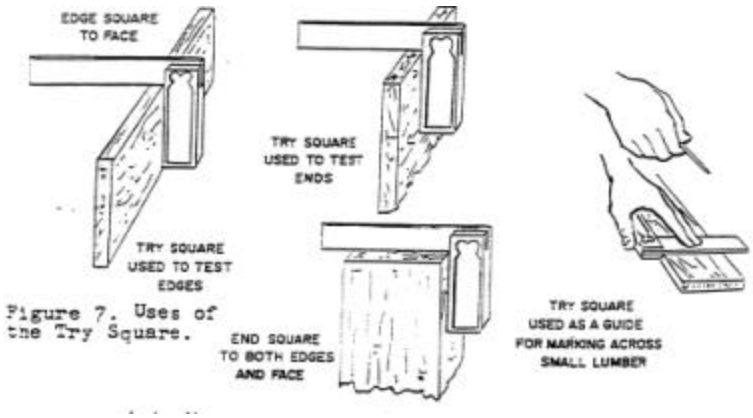


Figure 7. Uses of the Try Square.

(3) Maintenance and Care. The same maintenance given the carpenter's square should be given to the try square. Lightly oil the wooden handle occasionally with linseed oil to prevent it from drying out.

d. Wing Dividers

(1) Description. Dividers consist of a pair of legs joined together at or near their tops. Dividers of the type furnished in the engineer carpenter's tool set are called "wing dividers." The "wing" is an arc used to allow accurate repetitive measurements by means of a graduate scale and a setscrew. At one end of the arc is an adjusting screw spring that permits a fine setting of the legs.

(2) Uses. Dividers are used to mark lengths into equal parts, to scribe circles and arcs, or to transfer measurements from the work to a rule or from a ruler to the work.

(a) To set the dividers at a given distance, place the point of the divider on a graduation mark on a scale or on a rule. Set the leg at the desired distance. Tighten the setscrew holding the arc; then turn the adjusting screw in or out.

(b) To lay off equal spaces, set the legs at the desired spacing in the manner described above and lay the dividers along the line to be marked off rotating the dividers from one leg to the other.

(c) To scribe circles or arcs with the dividers, place the point of one leg on the center of the circle or arc and rotate the dividers letting the point of the other leg mark the material.

(d) The sharp point on one end of each leg may also be used as a scriber for marking boards.

(3) Maintenance and Care. Keep the points of the dividers sharp by rotating them against an oilstone. If they are dulled or bent, grind them by rotating them against a grinding machine. Take care to cool the points with water to prevent loss of temper. Take care also to not make one leg shorter than the other.

(a) When not in use set the setscrew lightly to prevent possible damage to the arc or bending of the dividers in case they roll to the floor.

(b) Dividers should be laid flat on the toolbox or hung in a rack when not in use. They should not be set on their points.

(c) Dividers should be kept lightly oiled.

e. Sliding T-Bevel

(1) Description. The sliding T-bevel consists of a slotted eight-inch steel blade set into a handle called the stock, beam, or head with a thumbscrew to hold it at any desired angle with the head.

(2) Uses. The sliding T-bevel is used for testing bevels or for making angles on a board. It may be set in various angles by the aid of triangles, a carpenter's square, or a protractor. To set the sliding T-bevel, at any angle, loosen the thumbscrew, place the edge of the handle against one side of the angle to be set off and set the blade against the other side of the angle. Tighten the thumbscrew to hold it.

(3) Maintenance and Care. Keep the sliding T-bevel lightly oiled and in a tool box when not in use.

f. Carpenter's Level

(1) Description. The carpenter's level can be made of many types of material with true surface edges. There are three bubble tubes in it, of which one is in the middle of one of the long edges. The others are at right angles to this and parallel to the sides of the level. It comes in both 48 and 24 inches.

(2) Uses.

(a) To test for a level surface, lay the carpenter's level on the surface and see where the bubble comes to rest. If the surface is level and the level is in adjustment, it will come to rest exactly between the two scratch marks. Turn the level end for end and recheck. The bubble should come to rest in the same place. If it does not raise the end of the surface being tested, which is toward the low end of the tube until, it checks level. If the level is out of adjustment, it can still be used. Note the position of the bubble in relation to the scratch marks. When the level is turned end for end, the bubble should come to rest at the same relative position to the scratch marks but toward the other end of the work being tested.

(b) To check for plumb, set the long side of the carpenter’s level against the upright to be tested and use the bubble, which is set in the end in the same manner, previously described.

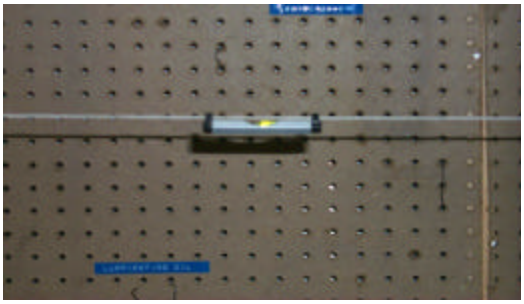
(3) Maintenance and Care.

(a) The carpenter's level should be handled gently to prevent scratching or gouging of the surface. Scratches or gouges in the true surfaces will make them untrue.

(b) Rub the level lightly with oil, if made of wood or metal; all other types of material will be wiped clean.

g. Line Level

(1) Description. The line level consists of a bubble tube set into a metal case with a hook at each end to permit it to be hung on a line or cord.



(2) Uses. The line level is used to test whether a line cord is level. It is particularly useful when the distance between two points to be checked is too long to permit the use of a board and carpenter's level. To use the level:

(a) Stretch a cord between the two points to be checked for plumb.

(b) Hang the line level on the cord and see whether the bubble rests in the middle of the tube. If it is not, raise the end of the cord that is toward the lower end of the bubble until the bubble rests in the middle of the tube.

(3) Maintenance and Care. The level is a delicate instrument. Keep it in a box when not in use to protect the bubble tube from being broken and the hooks from being bent.

h. Plumb Bob

(1) Description. The plumb bob is a pointed iron weight, weighing nine ounces. Holes at its top allow it to be hung on a cord.

(2) Uses. The plumb bob is used to check uprights for vertical (plumb).

(a) Fasten a cord long enough to extend below the end of the upright to be checked to the bob. Lay a rule or a piece of wood on the top of the upright so that it extends just two inches beyond the face of the upright. Hang the bob from the end of the rule or piece of wood. Measure the distance from the cord to the face of the upright. Move the upright in or out until the string is exactly two inches from the upright.

(b) Brace the upright to hold this vertical plumb while checking the plumb of the face that is at a right angle to the one just tested. Check the second face in the same manner as previously described. When both faces have been plumbed, the upright is vertically plumb.

(3) Maintenance and Care. Do not drop the plum bob to the ground when not in use. The point may be broken, which will cause it to hang incorrectly, or out of plumb. Keep the cord wrapped neatly around the bob when not in use to avoid wasting time trying to untangle it when it is needed and keep the bob lightly oiled to prevent rust.

i. Multiple Folding Rule

(1) Description. The multiple folding rule is of aluminum or wood and is six feet long. The sections are so hinged that it is six inches from the center of one hinge joint to the center of the next. It is graduated in sixteenths of an inch.

(2) Uses. For measuring distances.

(3) Maintenance and Care. The folding rule can be easily bent or broken if carelessly used, particularly when it is opened. Close the rule and keep it closed when not in use.

j. Tape Measure, 50 & 100 Foot

(1) Description. The steel tape is a ribbon of steel, 1/2 inch in width and 50 and 100 feet long. It is graduated in feet, inches, and fractions of an inch down to 1/8 inch. One end of the tape is fastened to a reel that is housed in a leather-covered metal box.

(2) Uses. For measuring distances greater than 25 feet.

(3) Maintenance and Care. Reel the tape back into the case whenever it is not actually being used. Do not permit the tape to be twisted. Keep the tape clean and lightly oiled.

k. Chalk line

(1) Description. The chalk line is a container with chalk and string on the inside. There is a crank on the out side for the rewinding of the string when not in use.

(2) Uses. The chalk line is used to mark straight lines.

(3) Maintenance. Keep clean and refill as needed. Chalk is included in the kit for refilling.

l. Twine

(1) Description. A one-pound ball of twine is 1020’ long of cotton string with a minimum 35 pound breaking strength. Some kits may contain a one-pound ball of polyamide string with 1950’. Minimum breaking strength of the polyamide ball is 70 pounds.

(2) Use. A wide variety of uses, such as to mark the boundaries of a building, also used with a line level to level fence posts and other projects.

(3) Maintenance. Keep clean and dry.

m. Apron, Construction Worker's

(1) Description. Nail apron made of Leather.

(2) Use. The nail apron may be used to store nails and small tools while working.

(3) Maintenance. Keep clean and dry.

2. BORING TOOLS, SCREWDRIVERS, PLIERS

a. Ratchet-Type Brace

(1) Description. The brace consists of a head, crank, ratchet box, and a chuck. The head is a circular wooden knob fastened to the crank. The crank is a steel shaft to provide leverage.

(2) Uses. The brace is used to turn auger bits, expansive bits, countersinks, or screwdriver bits. To insert a bit, hold the chuck with the left hand while turning the crank backward. Do not press with too much force on the head of the brace when boring

(3) Maintenance and Care. Occasionally grease the bearings of the head with light grease. Oil the handle bearings, jaws, and ratchet.

b. Hand Drill

(1) Description. The hand drill, ratchet type consists of a shaft with a handle at one end and a chuck for holding twist drills at the other. Near the middle of the shaft is a ratchet gear wheel with a crank handle attached which drives a smaller gear attached to the chuck.

(2) Uses. The hand drill is used for drilling holes in metal or wood.

(3) Maintenance and Care. Use light machine or engine oil on the gear teeth, the handle bearings, and the chuck.

c. Auger Bit Set

(1) Description. The auger bit is a tool designed for use with the brace to bore holes. The set consists of seven auger bits, varying in size from 1/4 inch to 1 inch, graduated in 1/8-inch increments. The bit has six features.

(a) The spur is a screw at the end of the bit that feeds or pulls the bit into the wood.

(b) The nibs are vertical cutters, which cut the side of the hole.

(c) The lips are horizontal cutters, which chip the wood in the bottom of the hole.

(d) The twist or flute carries the chipped wood away from the cutting edges and out of the borehole.

(e) The shank.

(f) The tang is the tapered top that fits in the brace.

(2) Uses. The auger bit set is used to bore holes in wood.

(3) Maintenance and Care. Make sure no nails or other metal or any other dirt is in the way of the bit before boring a hole. Clean and oil the bit after use. Keep the bits in the roll provided for that purpose when not in use. Use an auger bit file to sharpen the bit.

d. Drill Set, Twist

(1) Description. Twist drills are straight shank boring tools used for boring holes smaller than it is possible to bore with the smallest auger bit.

(2) Uses. The twist drill is used with the ratchet type hand drill for boring small holes in wood or soft metal.

(3) Maintenance and Care. Sharpen the drill bits on a grinding wheel. First grind the tip to the proper angle. Both cutting edges must make the same angle with the drill axis, and both cutting edges must be of the same length. Keep twist drills oiled and protected to prevent them from striking metal objects when not in use. A means of protection is to keep the set of twist drills bits wrapped in a piece of cloth, in such a manner that each drill is separated from the next by the cloth when not in use.

e. Expansive Bit

(1) Description. The tip of the expansive bit has an adjustable cutter that can be extended to fit various size holes, from 7/8 inch to 3 inches in diameter. Loosening the setscrew in the side of the bit and extending the cutter blade can vary the size of the hole. A scale on the cutter indicates the diameter of the hole.

(2) Uses. This bit is used for boring holes in wood larger than the largest auger. When using the expansive bit to bore completely through a board, clamp a piece of waste wood to the back of the piece to be bored through to prevent slipping when the bit comes through.

(3) Maintenance and Care. See Bit Set, Auger.

f. Countersink Bit

Figure 89. Countersink bit.

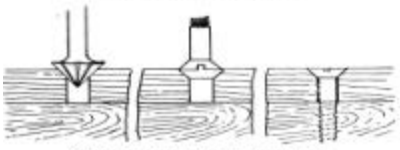


Figure 90. Using the countersink bit.

(1) Description. It has a "rose-head" shape head. This acts as a cutter type bit.

(2) Uses. Its purpose is to enlarge and taper a hole so that a screw head may be sunk flush with or below the surface.

(3) Maintenance and Care. Sharpen the cutting edges of the countersink flutes with a tapered file using extreme care to retain the original shape.

g. Screwdriver Bit

(1) Description. The screwdriver bit is a screwdriver with a shank designed to fit the chuck of a ratchet-type brace.

(2) Uses. As a regular screwdriver the bit used with the ratchet type brace.

(3) Maintenance and Care. Keep clean, with a light coat of oil.

h. Flat Tip Screwdriver

(1) Description. Flat tip screwdrivers are issued for use with slotted-head screws. The flat tip screwdriver normally is referred to as a "common" screwdriver. They are issued in lengths of 4″-8″ with various widths of tips.

(2) Uses. To drive or remove screws from bore holes, as a means of attaching one or more wooden or metal objects together.

(3) Maintenance and Care. Do not use the screwdriver as a lever or as a chisel. When the tip of a common screwdriver becomes nicked or rounded off from use, regrind it on the grinding machine. Grind the tip straight across to remove any nicks or rounded edges.

i. Pliers, Slip Joint

(1) Description. Pliers are holding or gripping tools. Slip joint pliers are pliers with straight, serrated (grooved) jaws.

(2) Uses. Pliers are used to hold material that is being worked on; to reach into and grasp objects that are hard to reach with the fingers; or to bend wire and small bars.

(3) Maintenance and Care. Keep the jaw serrations of the pliers sharp. Apply a light coating of oil. Keep the pin or bolt at the hinge just tight enough to hold the two parts of the pliers in contact.

j. Drill, Electric, Portable.

(1) Description. There are two drills in the kit. One is an electric 120-volt. The other is a cordless battery powered drill. The cordless drill has a rechargeable battery pack.

(2) Uses. The main purpose is to drill holes in wood or metal.

(3) Maintenance and Care. Keep chuck oiled and drill away from water.

k. Screw, Wood.

(1) Description. Wood screws are of the below listed sizes.

(a) 3/8″ (c) 1 1/2″

(b) 1 1/4″ (d) 3″

(2) Uses. For securing wood projects together

(3) Maintenance and Care. Keep clean, oiled and organized.

l. Wrench, Pliers.

(1) Description. 8 1/2″ vice grip

(2) Uses. The wrench is used to grip a wide variety of nuts or bolts.

(3) Maintenance and Care. Keep clean, with a light coat of oil

3. DRIVING AND PRYING TOOLS

a. Carpenter's Hammer

(1) Description. The carpenter's straight-claw nail hammer is a steel headed, wooden handled tool used for driving nails, wedges, and dowels. The "claw" portion is the two straight prongs used to pull out 8d and smaller nails. The other parts of the head are the eye and face.

(a) Hammer face types

1 The flat face is called a "plain" face. It is difficult to drive the head of a nail flush with the work surface without leaving hammer marks. The plain face hammer is used on rough work where the finish is not important.

2 A slightly rounded or convex face is called a "bell-faced". The bell-faced hammer is generally used in finish work. When handled by an expert it can drive the nail head flush with the surface of the work without damaging the surface.

(2) Uses.

(a) To drive nails simply grasp the handle with the end of the handle flush with the lower edge of the palm. Keep the wrist limber and relaxed. Grasp a nail with the thumb and forefinger of the other hand and place the nail point at the exact spot where it is to be driven. Unless the nail is to be driven at an angle, it should be perpendicular to the surface of the work. First rest the face of the hammer lightly on the nail and give the nail a few light taps to start it and to fix your aim. Then take the fingers away from the nail and drive the nail with finishing blows with the center of the hammer face. Strike the nail head squarely keeping the hand level with the head of the nail.

(b) To pull out a nail, slide the claw of the hammer under the nail head. Pullback on the handle extracting the nail until the hammer handle is nearly vertical. Then place a block of wood under the head of the hammer and continue to pull the nail completely free. The claw should not be used for pulling nails larger than an 8 d. For larger size nails, a wrecking bar is recommended.

(3) Maintenance and Care. Replace or tighten hammer handles, when broken or loose. If tile handle is loose, set it by striking the end of the handle with a mallet and drive the wedges back into the handle. Wedges may be of either metal or straight-grained soft wood. Do not use nails or screws. If the handle is broken, remove it, seat a new handle, and replace the wedges. If it is difficult to remove the old handle, saw it off close to the head and drive it through the larger end of the eye. Save and restore the face. Keep the hammer face clean and smooth. This is usually done by rubbing it with emery cloth. If it is necessary to grind the face to restore its surface, make notice of whether it is a bell or plain face and then grind it to obtain the proper shape. Dip the head in water often to prevent overheating and loss of temper while grinding. Do not grind the hammer face often, nor remove more material than necessary to restore the face.

b. Plastic Faced Hammers

(1) Description. The plastic faced hammer has a metal head on a wooden handle, with replaceable plastic faces that can be screwed onto the ends of the metal head.

(2) Uses. The plastic faced hammer is used for striking chisels and other tools that would be damaged by a metal hammer.

(3) Maintenance and Care. The plastic face is soft material and can be easily damaged. Restore the face by rasping off the damaged surface with a wood rasp, then smoothing the surface with a file and sandpaper. Take care to remove the same amount from each end of the head, to maintain the proper balance of the hammer. When the faces are too scarred for repair, unscrew them from the head and screw in new ones.

c. Nail Set

(1) Description. The nail set is a round steel tool, with one flat end for striking and a tapered end the tapered end varies in size.

(2) Uses. The nail set is used to drive a nail below the surface of the wood.

(3) Maintenance and Care. Nail sets require very little care. Keep them lightly oiled when not in use to prevent rusting. Replace nail sets that have mushroomed heads.

d. Pinch bar

Pinch-Bar

(1) Description. The pinch bar is a steel rod, usually of 3/4-inch material, with one pointed end and one chisel or wedge shaped end. The wedge is set at a slight angle to the bar.

(2) Uses. The pinch bar is used for light ripping and prying jobs.

(3) Maintenance and Care. Keep the pointed ends of the bar sharp by filing or by grinding the chisel point or the tips of the claws may be kept in condition in the same manner. Pinch bars require very little care. Keep them lightly oiled when not in use to prevent rusting.

e. Nailer, Portable, Pneumatic.

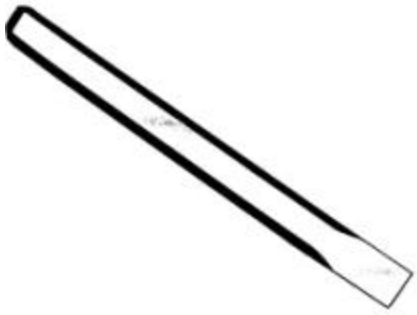
(1) Description. 15 LB 8 oz; holds 150 nails, capable of driving nails from 4” - 5” in length.

(2) Uses. Driving nails for wood frame construction.

(3) Maintenance and Care. Keep clean and lubricate moving parts.

4. CUTTING AND PARING TOOLS

a. Cold Chisels



(1) Description. The machinist cold chisel is a steel tool with a sharpened cutting edge on one end and a double beveled head at the other. The bevel of the cutting edge is usually 60 to 70 degrees.

(2) Uses. The cold chisel is used for chipping or cutting cold metal. Place the chisel with its cutting edge on the cutting line and strike the head of the chisel with a ball peen hammer to force the edge into the metal.

(a) It is better to make a series of light cuts rather than trying to cut completely through the cold metal all at once.

(b) When cutting steel, keep the edge of the chisel lubricated with light oil to reduce friction.

(c) When cutting cast iron, always cut from the edge toward the center to avoid breaking off corners of the material being worked upon.

(3) Maintenance. Keep cutting tip sharp without taking temper out of blade, also keep light coat of oil on it to avoid rust.

b. Wood Chisels

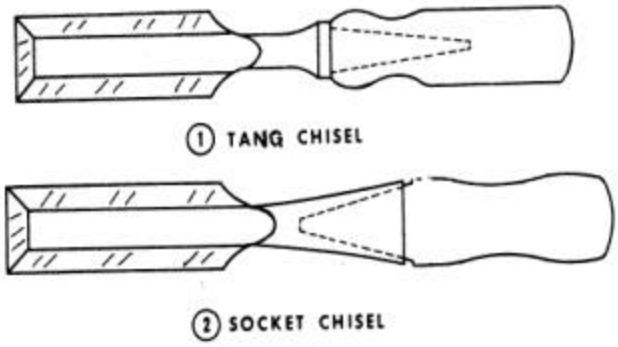
(1) Description. A wood chisel is a steel tool fitted with a wooden handle. It has a single bevel, cutting edge at the end of the steel part or blade.

(a) Types

1 Wood chisels are divided into two types (tang and socket) depending upon which of their handles are attached. They are also divided into types depending up on their weight, thickness, shape or design of the blade, and the work they are intended to do. These types are paring, firmer, and

framing. The framing chisel is the heaviest and most useful of these and is the chisel issued with engineer tool sets.

2 Framing chisels are socket type chisels. Their handles normally are fitted with an iron band to prevent them from splitting when struck by a mallet or plastic hammer.



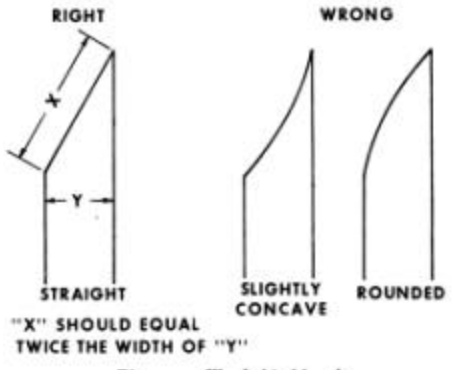
3 Tang chisels are used only for light work, which can be done by pushing or tapping with the hand against the end of the handle.

(2) Uses. Wood chisels are used to chip or to pare away sections of wood. Examples of this are in cutting a socket, preparing a lap joint, or paring the edge or surface of a board. Framing chisels are socket type chisels. Their handles normally are fitted with an iron band to prevent them from splitting when struck by a mallet or plastic hammer.

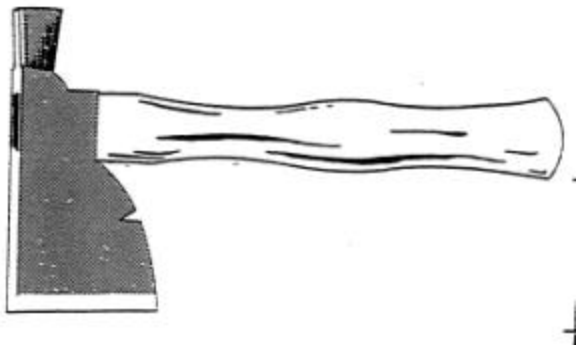
(a) Choose a chisel smaller than the width of the cut to be made and cut as much as possible with the grain of the wood. Cutting against the grain splits the wood fiber and leaves a rough job. Start the cut slightly away from guideline and continue away from guideline so that any splitting will occur in the waste and not in the finished work.

(b) Holding the chisel with the bevel down gives a lifting or gouging action. Holding the bevel up or away from the surface gives a planing action. Finish the cut by holding the chisel flat, bevel side up, on the surface of the cut and making light paring cuts. The cut will be smoother if the cutting edge is held at a slight angle to the direction of the cut.

(3) Maintenance and Care. Keep chisels in racks when not using them to protect their edges. Keep them clean and covered with a thin film of oil to prevent rusting. When the handle of a chisel becomes mushroomed from use, repair it. Never use the chisel to pry open boxes or as a screwdriver. Sharpen a wood chisel by using a grinding machine or oilstones. Use the grinding machine to form a new edge when the cutting edge has been nicked, or when the bevel cannot be restored by using the oilstone.



c. Half-Hatchet

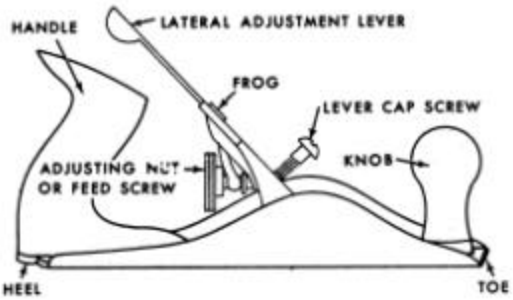


(1) Description. The half-hatchet is a chopping and driving tool. It has a wooden handle and a steel head. The blade has a notch for pulling nails. The edge of the blade is usually beveled only on one side. The single bevel is better for chopping along a line.

(2) Uses. The half-hatchet usually is held with one hand. Most effective use of the hatchet is made when cutting with the grain of the wood. Before using the tool, prevent deflection of the hatchet by clearing all branches and debris from the work area, and do not allow chips to accumulate on the work surface as work progresses. Do not use the notch in the blade to pull nails larger than 8d. For larger nails use the claws of a wrecking bar.

(3) Maintenance and Care. Inspect the half-hatchet frequently to see that the head fits tightly and that the handle is not split or broken. If the handle is loose, seat it into the eye by striking the end of the handle with a mallet and re-seat the wedges. If the wedges will not spread the end of the handle enough to make it tight, add another wedge or use larger wedges. Replace the handle if it is split or broken. If a broken handle is too tight to pull out of the head, saw off the handle close to the head and drive the remaining piece through the large end of the eye. Shape a new handle to fit, using a spoke shave or wood rasp. Seat the new handle. If it fits properly, saw off the projecting end and drive wedges into the handle. Do not use screws or nails for wedges. Place the half hatchets on their heads or hang them in a rack when not in use. After using a hatchet, clean, sharpen, and coat it with a light film of oil to prevent rusting. Do not drive a hatchet into the ground. Place the wood to be chopped on another block to keep the edge of the hatchet from striking the earth.

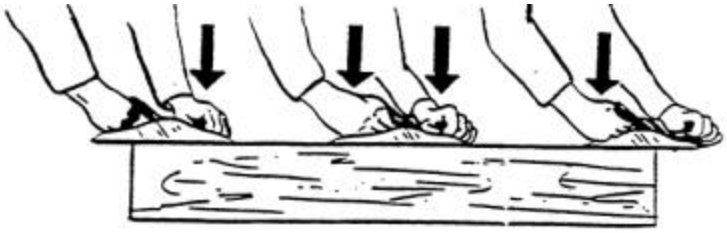
d. Smoothing Plane



(1) Description. A plane is a tool used to smooth boards or to remove wood from the surface or edge to obtain a desired thickness or width. The smoothing plane is a bench plane and is designed for use with both hands while the work is supported on a workbench or sawhorse. The smoothing plane is the plane issued in engineer tool sets. It is nine inches long. It is designed for general use in smoothing rough edges and surfaces where precise straight lines are not essential.

(2) Using the plane.

(a) Clamp the piece of wood securely in a vise, using scrap pieces of wood to prevent marring of the surface, or nail a thin strip of wood to the piece and push the piece being worked upon against it. Control the plane bench with both hands. Hold the plane with the left hand on the knob and the right hand on the handle. Make thin cuts. The most common mistake made by beginners is to adjust the plane so that it cuts too deep. The shavings should come through the mouth and be deflected by the cap-iron. If the mouth becomes clogged, clear it with a splinter of wood. Never with a screwdriver or other metal objects.



(b) Bear down firmly on the knob when beginning the stroke, and evenly on both knob and handle when in the middle of the stroke. Lighten the pressure on the knob and bear down on the handle when finishing, the stroke. Keep well over the work, so the pressure can be carefully watched. On return strokes, raise the cutting edge so it will not drag on the finished surface. The plane should be angled 10 to 15 degrees with each stroke (in making rough cuts, about 30 degrees). If the grain is torn or roughened by the plane, reverse the direction in which the plane is being pushed. When planing sides and edges, work from the outside toward the middle and as much as possible with the grain. Use steady, level strokes.

(c) Edges can be kept true holding a block of wood against the side of the work and under the plane as a guide and as support. In planing the end grain, plane from both edges of the work toward the center to avoid splitting the edges.

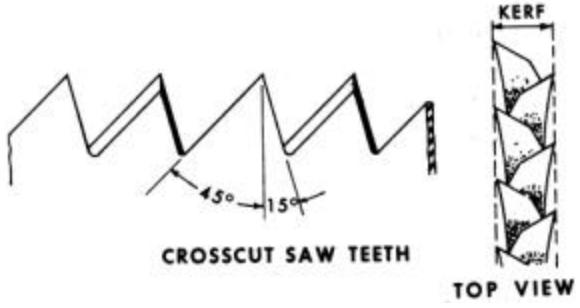
(3) Maintenance and Care. Sharpening plane blades in the same manner as described for the wood chisel. The angle of the bevel is 25 degrees. Take care to keep the cutting edge straight and exactly perpendicular to the length of the blade. Round off the corners slightly. Never lay a plane face down on its cutting surface. Always lay it on its side, otherwise the blade may be nicked or dulled. Ensure that the wood to be planed is entirely free of nails, dirt, or other foreign matter.

e. Hand Saws

(1) Description. Saws are tools for cutting wood or metal. The handsaw consists of a steel blade with a handle at one end. The blade is narrower at the end opposite the handle. This end of the blade is called the "point" or "toe". The end of the blade nearest the handle is called the "heel". One edge of the blade has teeth, which are two rows of cutters. When the saw is used, these teeth cut two parallel grooves close together. The chips (called "sawdust") are pushed out from between the grooves (the kerf) by the beveled part of the teeth. The teeth are bent alternately to one side or the other to make the kerf wider than the thickness of the blade. This bending is called the "set" of teeth. The number of teeth per inch, the size and shape of the teeth, and the amount of set depends on the use to be made of the saw and the material to be cut. The number of teeth points per inch describes saws, except the hacksaw. There is always one more point than there are teeth per inch. A number stamped near the handle gives the number of points of the saw.

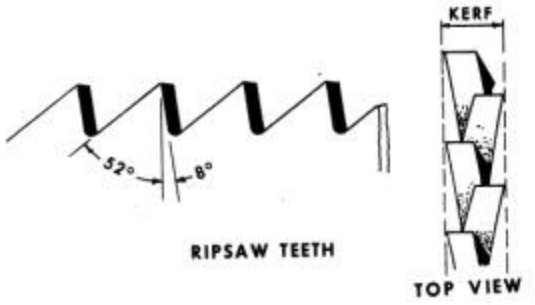
(a) Types

1 Crosscut. The crosscut saw is used for cutting across the grain of the wood. The blade has eight or more points per inch. The points are sharpened like the ends of knife blades. A crosscut with coarse teeth and a wide set is needed for cutting green, unseasoned wood. A fine-toothed saw does more accurate cutting and is best for dry, seasoned wood.



2 Ripsaw. The ripsaw is designed for cutting with the grain of the wood. The teeth, unlike those of the crosscut saw, are sharpened straight across the leading nearly vertical edge, or at right angles to the edge of the

blade. Thus the teeth of the ripsaw are like two rows of chisels in their action. The ripsaw in the engineer tool set has 5 1/2 points per inch.



(2) Uses. In cutting with either the crosscut or the ripsaw, first draw a guideline for the saw to follow. Grasp the wood with the left hand and brace it with one knee to hold it securely. Guide the saw with the left thumb by resting it against the blade above the teeth. Keep your right shoulder directly behind the cut to be made. This will ensure that the saw is cutting in a plane perpendicular to the surface of the wood.

(a) Rest the teeth of the saw against the edge of the wood with the blade on the waste side of your guideline. Start the cut by drawing the saw toward you to make an initial groove.

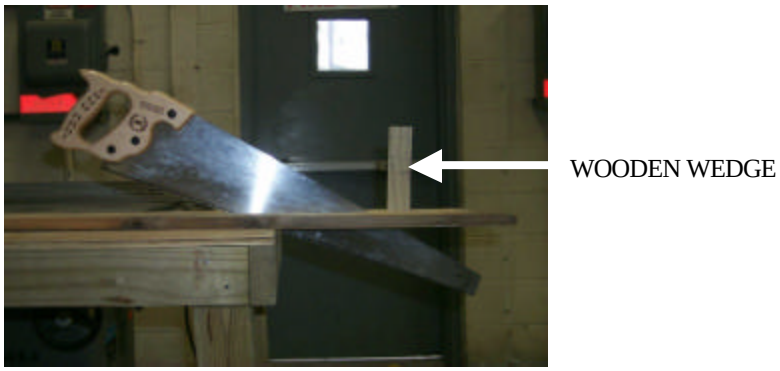
(b) Hold the saw lightly. Do not force it into the wood, but simply draw it back and forth, using long strokes.

(c) If the saw tends to run off the line or the cut is not perpendicular to the work, slightly twist or bend the blade back into place.

(d) Test a portion of the blade occasionally with a try square to ensure that the cut is being made perpendicular to the surface of the wood.

(e) The crosscut saw should make an angle of 45 degrees between the edge of the saw and the surface of the wood. The ripsaw should be used at an angle of 60 degrees.

(f) In ripping long boards, insert a wooden wedge into the cut to spread it apart and keep the saw from binding.



(3) Maintenance and Care. Care must be taken that the saw is not crooked. If the saw binds in the cut and pressure is then applied to force it through the wood, a kink is almost certain to result. A crooked saw blade is useless.

(a) Make certain that nails, spikes, and other foreign objects are removed from the wood before it is cut.

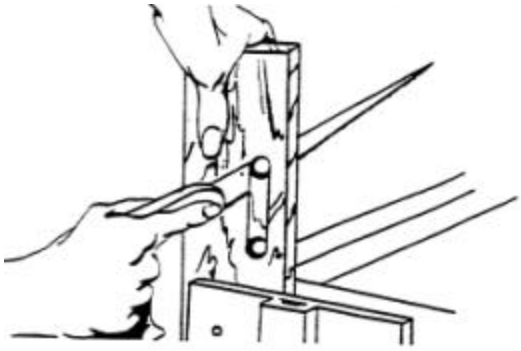
(b) When not in use, saws should be oiled and kept in a toolbox. Saws rust easily, and a rusty saw will bind in the cut.

f. Nested Saws

(1) Description. The nested saws consist of a handle common to three blades, which are the keyhole, compass, and plumbers saw blade. The handle typically is of wood and shaped somewhat like a pistol rip. Each of the blades has a slot in the heel by which it is fastened to the handle. The handle has a thumbscrew that is tightened to hold the blade securely in place.

(a) Types of blades.

1 Keyhole Saw Blade. The keyhole saw blade is narrow. The point is narrow enough to enter a 1/4-inch hole. It is commonly used for cutting keyholes to fit locks in doors, and for smaller types of work. It cuts a wider kerf than either the crosscut or the ripsaw, in order that the blade may turn quickly to make curved cuts.



2 Compass saw. This blade is designed for cutting curves. It is also used for starting cuts to be completed by larger saws, particularly interior cuts. The blade is tapered to a point and the teeth are filed in such a manner that the saw may be used either for crosscutting or for ripping. The kerf left by this saw is wider than that of either the crosscut or the ripsaw, in order to provide freedom for the blade to turn when cutting curves.

3 Plumber's saw. This is a heavy blade with fine teeth designed for cutting nails or soft metals. The blade is thick enough to permit a wood cutting saw to pass freely through the cut it makes in a nail.

(2) Uses. When using a compass saw or a keyhole saw, you must first bore a hole with an auger bit. Then insert the compass or keyhole saw into the hole and start the cut, working slowly and carefully with a minimum of pressure. These narrow bladed saws are easily bent. When the cut is long enough to permit it, remove the compass saw or keyhole saw and finish the cut with a regular crosscut saw or ripsaw. Use a plumber's saw to cut through any nail encountered while sawing. Then continue the cut with the regular wood saw.

(3) Maintenance. Attempt to keep saw blades straight with a light coat of oil.

g. Files

(1) Description. Files are hardened steel tools. Their surfaces are covered with sharp edged furrows or teeth. Files are used for cutting, smoothing off, or removing small amounts of metal, wood, plastic, or other material. Files are fitted with removable handles and should never be used without the handle on the tang.

(a) Types. There are over 3,000 types of files. Files may be square, triangular, round, half-round, rectangular, or tapered toward one edge in cross-section. They may be single cut, in which case the rows of teeth cross one another. Some of these are discussed below.

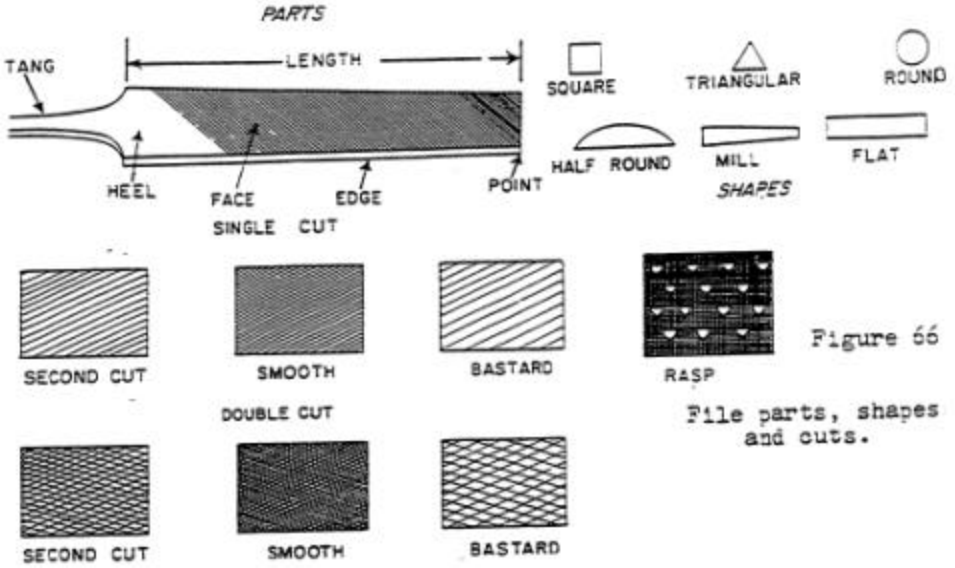


Figure 66

File parts, shapes and cuts.

1 Flat. The flat file is rectangular in cross-section and is tapered both in width and in thickness. It may be either single-cut or double-cut. The flat file is a general-purpose file.

2 Tapered. The tapered file is triangular in cross-section and is tapered on all three sides. The slim taper is smaller in cross-section than a regular taper. Because of their shape, tapered files can get into sharp angles and can be used for filing handsaws.

3 Auger Bit. The auger bit file is a special file used for sharpening the nibs and lips of auger bits. At either end is a small file or the middle section forms the handle. The file is seven inches long. At one end the faces are single cut with safe edge; that is, the edges have no teeth. At the other end the faces are double cut.

4 Flat or Mill. Both flat or mill files are used for sharpening the 2 man and 1 man crosscut saws. The mill file is thinner at one edge than at the other. One edge of the mill file has no teeth and is called the safe edge. Mill files are single-cut.

5 Wood Rasp File. The wood rasp is a very course half-round file. The rasp teeth consist of points instead of V shaped projections, running diagonally across one or more surfaces. It has a tang at the point for a handle, and should never be used without a handle. The rasp is used for cutting away wood or for finishing rough edges left by a new saw.

(2) Uses. Select a file for the job by considering the amount of material to be removed. Fit a handle to the file selected, except the auger bit file. Slip the handle over the tang of the file and then striking the base of the handle sharply to set the tang securely in the handle.

(a) Secure the work piece in a vise or other device. Hold the file and use alternating strokes, right to left then left to right at an angle of about 30 degrees for rough cutting.

(b) In finish filing, use parallel strokes across the work. The fingers held lightly on the file can feel any unevenness in the work.

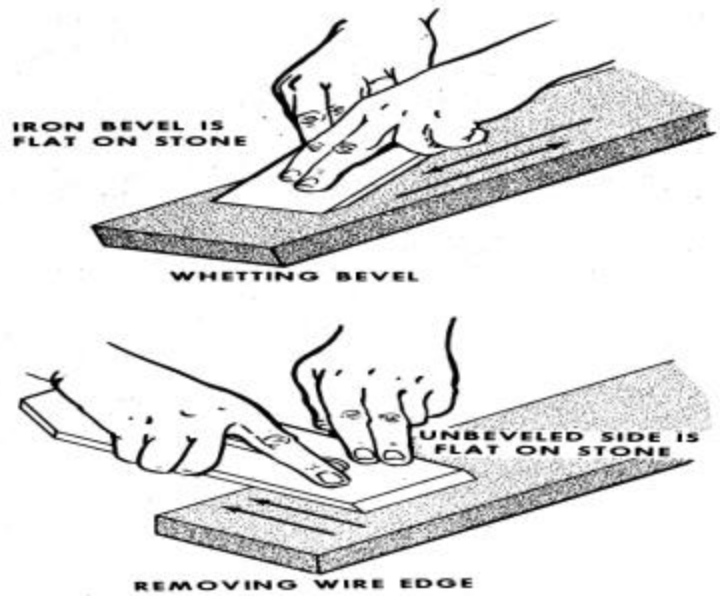
(3) Maintenance and Care. New files should be carefully broken in by first using them on soft material. Clean with file card in the event file is clogged. Files should be cleaned after each use and a light coat of oil applied before Storage.

h. Oil Sharpening Stones

(1) Description. The issued oilstone (sharpening stone) is a natural or artificial stone three inches wide, eight inches long and one inch thick. One face is of coarse grit for rapid cutting; the other a fine grit for slow, fine cutting. A wooden box should be made to protect it.

(2) Uses. The sharpening stone is used for putting keen edges on tools after they have been ground or filed to shape. A "feather" or "wire" edge can be removed by rubbing each side of a cutting edge alternatively against the oilstone. To use, set the stone on a firm base and apply a few drops of light oil to its surface. Hold the tools cutting edge at the desired angle and with a circular motion move across the face of the stone and apply only enough pressure to cause the stone to cut.

(3) Maintenance and Care. A good stone should be soaked in light (No. 10 or lighter) oil before each use. This not only cleans the pores of the stones and gives better cutting action, but also acts as a lubricant for the tool being sharpened.

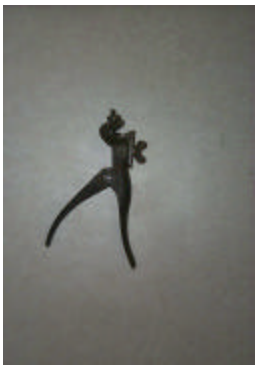


(a) If a stone becomes too oily after much use and presents a "slick" surface on which the tool slips. Boil the stone in water. This will

clean the pores of the embedded materials. After the stone has dried, oil it again before using.

(b) When an oilstone becomes uneven through use, dress it by rubbing it against a piece of sandpaper, emery cloth, or a grindstone.

i. Saw Set



(1) Description. The saw set is a tool that, by means of a plunger and anvil, bends the teeth of the saw outward to make the kerf wider than the thickness of the blade of the saw.

(2) Uses. The saw set is used to reset damaged saw teeth.

(3) Maintenance. Apply a light coat of oil when not in use.

j. Oiler

(1) Description. The oiler is usually a canister that contains one pint of lubricating oil, which is forced out of the oilier by depressing the handle trigger.

(2) Uses. To hold oil while coating tools during maintenance.

(3) Maintenance. Keep clean with a light coat of oil.

k. Lubricating Oil.

(1) Description. One pint or quart of oil that is normally 10 wt. oil

(2) Use. To keep tools lubricated and to prevent rust.

(3) Maintenance. Keep clean.

l. Saw, Circular, Portable, Electric.

(1) Description. The portable electric circular saw blade spins at 5800 RPM. The blade (8″ in diameter) is a combination rip and cross cut type.

(2) Use. Used to rip or cross cut lumber.

(3) Maintenance. Clean after use and change the blade as needed to keep a sharp blade on the saw.

m. Blade, Circular Saw, Wood cutting.

(1) Description. Combination blade for the circular saw.

(2) Use. For cutting wood with the circular saw.

(3) Maintenance. Keep clean and sharpen as needed.

n. Aural Protectors.

(1) Description. Ear Muff type hearing protection.

(2) Use. Hearing protection for any loud noises. Such as the noise from the circular saw, table saw etc.

(3) Maintenance. Keep clean and secure in box when not in use.

o. Goggles, Industrial.

(1) Description. Plastic frame eye protection.

(2) Use. Use when operating any tool that presents a possible eye hazard.

(3) Maintenance. Clean after each use for the next Marine that will need them.

p. Shears, Metal Cutting, Hand.

(1) Description. Duck bill combination, single lever, 12” overall length.

(2) Uses. Used for cutting light metal and wire.

(3) Maintenance. Keep clean, with a light coat of oil.

5. INVENTORY AND MAINTENANCE

a. Inventory. All sets, kits, and chests contain a stock listing which lists all the tools for that particular set, kit or chest. This listing is called an SL-3. The SL-3 not only contains the name of each tool in the kit, but also contains:

(1) Description of the tool

(2) The National Stock Number (NSN) of each tool, which enable the ordering missing or unserviceable components.

(3) The unit of issue (i.e. - each, roll, feet, etc) for that particular tool.

(4) The quantity of each tool that is to be in that particular set, kit or chest.

(5) Some SL-3's contain pictures of the components of that set, kit or chest.

(6) A description of the set, kit or chest and how it is used.

b. Maintenance. It is every engineer's responsibility to ensure they are familiar with all the tools and equipment, and their use. Also the cleaning and maintenance of each.

6. GENERAL SAFETY RULES IN USING HAND TOOLS

a. Before using any hand tool, inspect it. Repair and replace loose, splintered or defective handles, damaged blades or parts; rough edges or burs; and any other defects that lessen the strength of the hand tool or make it unsafe for use.

b. Store hand tools in a suitable storage space so that the tools do not injure persons who are storing removing, or working with them in the tool room. Serious injuries can result from a cluttered tool room.

c. Be sure hand tools are not dirty, oily, or greasy. Dirt or grease can cause the tools to slip out of the hand or off the work surface, resulting in injury.

d. Do not carry sharp edged or pointed tools in pockets where they can protrude and cause injury. Types of tools that can be carried on the person, like the machete or small twist drill bits, should be carried in a safe container or sheaths.

e. Do not use tools made of metal or power tools in locations where sources of ignition may cause a fire or explosion.

f. Wear safety goggles or other approved safety type face and eye protectors when breaking rocks, grinding, striking metal with metal, drilling, driving wedges chipping, or performing similar operations that might result in flying particles. Be sure others in the vicinity are protected in the same way.

g. Do not toss tools from one location to another. Do not drop tools to another level or throw them to another worker. When hand tools cannot be passed between personnel use suitable containers or rope.

h. Do not work on electrical circuits while the current is on. Turn the current off at the source. Even though a wooden handle may give some protection, the current could arc and cause body burns as well as damage to the hand tool.

i. Do not wear loose fitting (or torn clothing, or jewelry that may cause injury by becoming entangled with the hand tools.

j. Steady or secure with clamps or vises any loose material to be cut, sheared, chiseled, or filed to prevent the tool from slipping and causing injury.

k. Keep all hand tools in good condition because dull or defective tools can injure the user or others in the vicinity.

l. Do not swing a chopping or chipping tool until certain that no one in the vicinity will be endangered by the back swing; by a possible glancing off of the tools; by chips flying from the work or by a tool head loosening from the impact of the work.

m. Do not allow pointed or edged tools to lie around on work surfaces, sawhorses, or on the ground in such a position that persons brushing against them may suffer injuries. When not in use all tools should be placed in a toolbox or in a position that will prevent injuries to persons in the area.

n. When hand tools are being used, do not expose fingers or parts of the body of the worker or those in the vicinity to injury by the tool.

o. Use each hand tool only for the purpose, which it is intended. Tools used improperly can break or become damaged in a manner that may cause injury.

7. POWER TOOLS

(a) Radial Arm Saw

(1) The radial arm saw can be positioned for most angle cutting and finishing work when equipped with the proper accessories. The radial arm saw can be fixed for ripping as well as cross cutting. The arm can be moved to an angle of 45 degrees to 90 degrees to the fence "left or right". The motor can be tilted allowing for bevel cutting.

(2) Safety rules for the Radial Arm Saw

(a) The stock must be held firmly on the table and against the fence on all cutting operations.

(b) Before turning on the motor, be sure clamps and locking devices are tight. Check depth of cut and table slope.

(c) Keep the guard and the anti kickback device in position at all times.

(d) Maintain a six-inch margin of safety, keep your hands this distance away from the saw blade at all times.

(e) Shut off motor and wait for the blade to stop turning completely before making any adjustments.

(f) When ripping, always feed stock into the blade so that the bottom teeth are turning toward you.

b. Saw, Circular, Portable, Electric

(1) This power tool is also called an electrical handsaw. Its size is determined by the diameter of the largest blade it will take. The depth of cut is adjusted by raising or lowering the position of the base shoe. On most saws it is possible to make beveled cuts by tilting the shoe. The types of blades that are used with the electric handsaw are; Rough cut combination, Rip, Crosscut, and standard combination or mitered. To use a portable saw grasp the handle firmly with one hand with the forefinger ready to operate the trigger switch. The other hand should be placed on the hand knob. Rest the base on the work and align the guide mark with the layout line. Turn on the switch, allow the motor to reach full speed, and then feed it smoothly into the stock. Release the switch as soon as the cut is finished. Hold the saw until the blade stops.

(2) Safety Rules for the Portable Circular Saw

(a) The stock must be well supported in such a way that the kerf will not close and bind the blade during the cut.

(b) Be careful not to cut into supporting devices.

(c) Adjust the depth of the cut to the thickness of the stock plus 1/8 of an inch.

(d) Be aware that kickback can occur at anytime. Kickback is the tendency of the saw to lift and back out of the wood piece. When the blade binds or encounters excessive resistance (dull blade).

(e) Always wear ear and eye protection.

(f) Unplug power source before changing blade.

c. Jig Saw/Saber Saw

(1) The saber saw is also called a portable jigsaw. It is used for a wide range of light work. The stroke of the blade is about l/2 inch. The saw operates at a speed of approximately 2500 strokes per minute.

(a) For general-purpose work, a blade with ten teeth per inch is satisfactory. Always select a blade that will have at least two teeth in contact with the edge being cut.

(b) Saws will vary in the way the blade is mounted in the chuck.

(c) The saber saw can be used to make straight or beveled cuts. Curves are usually cut by guiding the saw along a layout line. However, circular cuts may be made more accurately with a special guide attachment.

(d) Since the blade cuts on the upstroke, splintering will take place on the topside of the work.

(2) Safety rules for the Saber/Jig Saw

(a) The switch must be in the off position before plugging the saw in.

(b) Select the correct blade.

(c) Disconnect the saw before you change the blade or for adjustments.

(d) Place the base of the saw firmly on the stock before cutting.

(e) Turn on the motor before the blade makes contact with the work.

(f) Do not attempt to cut curves so sharp that the blade will be twisted.

d. Portable Electric Drills

(1) Portable electric drills come in a wide range of types and sizes. The size is determined by the chuck capacity; usually 1/4, 1/8, or 1/2 inch. Speed of approximately 1000 rpm is best for woodworking.

(2) Bits for portable electric drills come in several types:

(a) Spade bits for light duty work.

(b) High speed twist drills.

(c) Extended double twist bits.

(d) Ship auger.

(3) Safety rules for portable electric drills.

(a) Select the correct drill bit for your work and secure it, in the chuck.

(b) Hold the stock so that it does not move during operation.

(c) Be sure that the switch is in the off position and the plug disconnected before changing drill bits.

(d) Hold the drill firmly in one or both hands and at the correct drilling angle.

(e) Turn on the switch and feed the drill into the work. The amount of pressure required on the drill will vary, according to the size of the drill and the kind of wood being drilled.

(f) During operation keep the drill aligned with the direction of the hole.

(g) When drilling deep holes, especially with a twist drill, withdraw the drill several times to clear the hole.

(h) Always remove the bit from the drill as soon as you have completed your work.

e. Cordless Driver/Drill and Charger

(1) Refer to operating instructions of electric drill.

(2) Safety instructions for charger

(a) Before Using A Battery Charger. Read all instructions and cautionary markings on battery charger and battery pack.

(b) Caution. To reduce risk of injury, Porter-Cable charger Model 8501 should only be used to charge Porter-Cable battery pack Model 8500. Other types of batteries may burst causing personnel injury and damage. Do not charge Porter-Cable Model 8500 battery pack with any other charger.

(c) Do not expose charger to rain, snow or frost.

(d) Do not operate charger if it has received a sharp blow, been dropped or otherwise damaged in any way; take it to a qualified serviceman.

(e) Do not disassemble charger or battery pack. Take it to a qualified serviceman when service or repair is required. Incorrect reassembly may result in a risk of electric shock or fire.

(f) Unplug charger from outlet before attempting any maintenance or cleaning to reduce risk of electric shock.

(g) Charge the battery pack in a well ventilated place, do not cover the charger and battery pack with cloth, etc., while charging.

(h) Do not charge battery pack when the temperature is BELOW 50 degrees F or ABOVE 104 degrees F. This is very important for proper operation.

(i) Do not incinerate battery pack as it can explode in a fire.

(j) Do not charge battery in damp or wet locations.

(k) Do not attempt to charge any other cordless tool or battery pack with the Porter-Cable Model 8501 charger.

f. 10" Tilting Arbor Saw

(1) The tilting arbor saw is also referred to as the table saw. It is used for ripping stock to width and cutting it to length. It can also cut bevels, chamfers and tapers. When used for construction the smaller 8 to 1O inch size table saw is used.

(2) Safety rules for the tilting arbor saw

(a) Be sure the blade is sharp and right for the job.

(b) Make sure the saw is equipped with a guard and use it.

(c) Extend the blade 1/4 inch above the stock to be cut.

(d) Maintain a 4-inch margin of safety. (Do not let your hand come closer than 4 inches to the operating blade).

(e) Always use a push stick when ripping short narrow pieces.

(f) Stop the saw before making adjustments.

(g) Remove any special blades after use.

(h) Control the feed and the direction of the cut.

(i) As work is completed, turn off the machine and remain until the blade stops turning.

(j) Clear the saw table of all waste.

(k) Lower the blade when not in use.

g. Portable Sanders

(1) Portable sanders include three basic types: belt, disc, and finish.

(2) Sanders vary widely in size and design. The manufacturer’s instructions should be followed carefully in the mounting of abrasive belts, discs, and sheets. The belt sanders size is determined by the width of the belt.

(3) Using the sander takes some skills. Make sure the stock is supported firmly and make sure the switch is in the off position before plugging in the electrical cord. Check the belt and make sure it is tracking properly.

(4) Hold the sander over the work and start the motor. Lower the sander carefully and evenly onto the surface. When using belt and finish sanders, make sure to travel with the grain, move it forward and backward over the surface. Do not press down on the sander.

(5) When the work is completed raise the sander from the surface and allow the motor to stop.

(6) Finishing sanders are used for final sanding when only a small amount of material needs to be removed. There are two types: orbital and oscillating.

(7) Safety rules for portable sanders

(a) Ensure that you are wearing eye and ear protection.

(b) Make sure that you are not wearing any loose clothing or jewelry.

h. Jointers

(1) The jointers are used for jointing and planing operations. These operations are basically the same. Jointing cuts the edge of the wood to make it square. Planing is identical to jointing except for the position of the work piece. For planing, the major flat surface of the work piece is placed on the table of the jointer with the narrow edge of the work piece against the fence.

(2) Safety rules for the jointer.

(a) Before turning on the machine, make adjustments for the depth of the cut and position of the fence and that the guard is operating properly.

(b) The maximum cut for jointing on a small jointer is 1/8 inch for the edge and 1/16 inch for a flat surface.

(c) Stock must be 12 inches in length and stock to be surfaced must be 3 1/8″ thick.

(d) Use stock free from knots and splits.

(e) Maintain at least a four-inch margin of safety.

(f) Use a push block when planing a flat surface.

(g) Do not plane end grain unless the board is at least 12 inches wide.

(h) When work is completed turn off the machine.

i. Pneumatic Stick Nailer

(1) Operation:

(a) Always handle this tool with care; never engage in horseplay. Never pull trigger unless nose is directed toward the work. Keep others a safe distance from the tool while tool is in operation as accidental actuation may occur, possibly causing injury.

(b) The operator must not hold the trigger pulled except during fastening operation as serious injury could result.

(c) Keep hands and body away from the discharge area of the tool. A contact arm tool may bounce from the recoil of driving a fastener and an unwanted second fastener may be driven possibly causing injury.

(d) Check operation of the contact arm mechanism frequently. Do not use the tool if the arm is not working correctly as accidentally driving of a fastener may result. Do not interfere with the proper operation of the contact arm mechanism.

(e) Do not drive fasteners on top of other fasteners as this may cause deflection of fasteners, which could cause injury.

(2) Safety Rules for Pneumatic Nailer

(a) Always wear ear and eye protection.

(b) Do not use oxygen, combustible gases, or bottled gases as a power source for this tool as tool may explode, possibly causing injury.

(c) Do not use supply sources, which can potentially exceed 200 psi. As tool may burst, possibly causing injury.

(d) The connector on the tool must not hold pressure when air supply is disconnected. If a wrong fitting is used, the tool can remain charged with air after disconnecting and thus will be able to drive a fastener even after the airline is disconnected possibly causing injury.

(e) Do not pull trigger or depress contact arm while connected to the air supply as the tool may cycle, possibly causing injury.

(f) Always disconnect air supply:

1 Before making adjustments.

2 When servicing the tool.

a While clearing a jam.

b When tool is not in use.

(1) When moving to a different work area, as accidental actuation may occur, possibly causing injury.

(2) At the completion of the day.

(g) When loading tool:

1 Never place a hand or any part of body in fastener discharge area of tool.

2 Never point tool at anyone.

3 Do not pull the trigger or depress the trip as accidental actuation may occur, possibly causing injury.

(8) General rules for power tools

(a) Safety must be practiced continually. Before operating any power tool, read the manual to become thoroughly familiar with the way the tool works and the correct way to use it.

(b) You must be wide-awake and alert. Never operate a power tool when tired or ill. Know what you are going to do and what the tool is capable of doing. Make all adjustments before turning on the power. Be sure the blades and cutters are sharp and are of the correct type for the work. While operating a power tool, do not allow yourself to be distracted) Keep all safety guards in position and wear safety glasses and hearing protection. When operation is completed, turn off the power and wait until the moving parts have stopped before leaving the machine. When making adjustments to power tools the plug should be disconnected from the power source.

(c) Always make sure that the source of the electrical power is the correct voltage and that the tool switch is in the "OFF" position before it is plugged into an electrical outlet.

(d) The electrical cord and plug must be in good condition and must provide a ground for the tool. If hooking up to a generator or extension line, make sure the conducting wire is large enough to prevent excessive voltage drop.

(e) Place electrical extension cords where they will not be damaged or interfere with other workers.

(f) Wear clothing appropriate for the work and weather condition. Keep utility shirts and jackets buttoned. Never wear loose, ragged clothing or jewelry around moving machinery.

(g) Never leave power tools running or unattended. Be sure the motor is turned OFF prior to leaving a power tool.

(h) **All portable electric tools should not be operated near flammable liquids or in gaseous or explosive fumes. Motors in the tools normally spark. Do not expose power tools to rain.**

9. WOOD FRAME CONSTRUCTION

(a) Framing is the rough timberwork of a building.

(b) Types of Wood Frame Construction

(1) Heavy Wood Framing

(a) Heavy wood framing consists of framing members at least six inches in dimension (timber construction).

(b) This type of construction is used in structures such as bunkers and nonstandard bridges.

(2) Light wood framing

(a) Light framing is used in barracks, administration buildings, light shop buildings, hospital buildings, and similar structures.

(b) Light wood framing consist of framing members of common lumber as in 2 x 4's, 1 x 2's, etc.

c. The major differences between light and heavy framing are the sizes of the timber used and the types of fasteners used.

10. LUMBER

a. Size. Lumber is usually sawed into standard size, length, width, and thickness. Standards have been established for dimension differences between quoted size of lumber and its standard sizes when dressed. Quoted sizes refer to the dimensions prior to surfacing; these dimension differences must be taken into consideration. A good example of the dimension difference is the common 2 x 4 untreated. The familiar quoted size 2 x 4 is the rough or nominal dimension but the actual dressed size is 1 1/2 by 3 1/2 inches. **The treated lumber may vary due to swelling during the pressure treating process.**

b. Grade. Lumber is subdivided into classifications of select lumber and common lumber. Common lumber is suitable for general construction and utility purposes. Common lumber is graded from No 1 to No 5 common (No 1 being of the best grade). No 2 common are the most common used for framing construction. Plywood, on the other hand, is grades a little different with the best being

AA and the worst being CD. CD is the most common grade used for exterior sheathing.

11. CONSTRUCTION HARDWARE

a. Nails

(1) Common Nails. The common wire nail is used in housing construction framing.

(2) Finishing Nails. The finishing nail is made of finer wire and has a smaller head than the common nail. It may be set below the surface of the wood and leaves only a small hole easily filled with putty. It is generally used for interior and exterior finishing work and for finished carpentry and cabinet making.

(3) Scaffold or Form Nails. These nails appear to have two heads. The lower head (shoulder) permits the nails to be driven securely home while the upper head projects above the wood to make it easy to pull. This nail is not meant to be permanent.

(4) Roofing Nails. Roofing nails are round-shafted, diamond-pointed, galvanized nails of relatively short length and large head. They fasten flexible roofing and resist continuous exposure to weather.

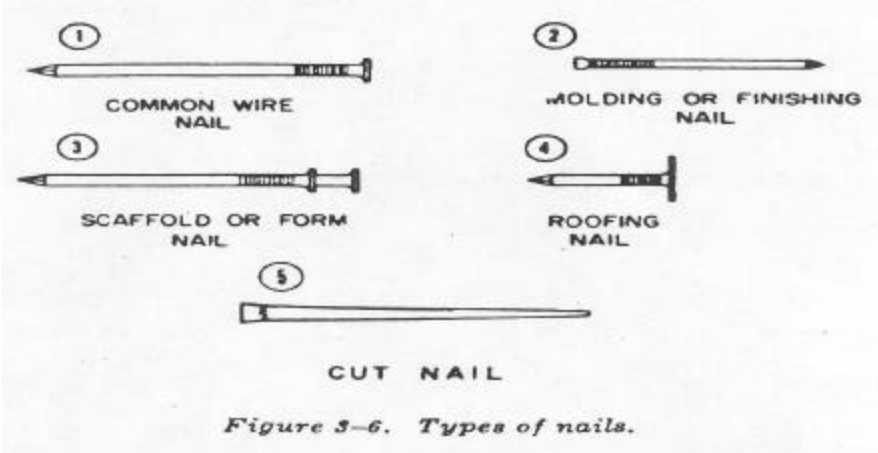
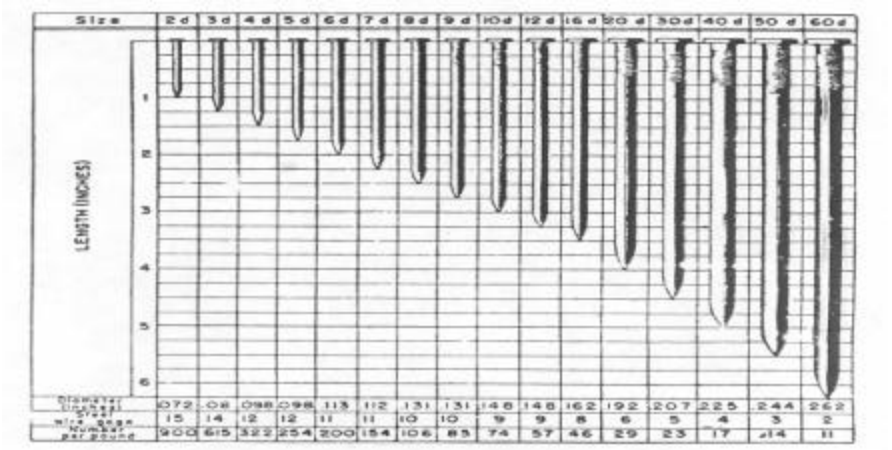


Figure 3–6. Types of nails.

(5) Cut Nails. Cut nails are wedge-shaped with a head on the large end. They are often used to nail flooring because they are of very hard steel and have good holding power.

b. Nail Size. Nail sizes are designated by the term "penny." This term applies to the length of the nail. The "d" next to the number is the abbreviation for "penny." The approximate number of nails per pound varies according to the type and size. Common nails range from 2d, which are 1 inch long and contain approximately 900 nails per pound, to 60d, which are 6 inches long and contain approximately 11 per pound. The nail you use should be at least three times as long as the thickness of the wood it is intended to hold. Two-thirds of the length of the nail is driven into the second piece for proper anchorage; one-third anchors the piece being fastened. The 16d common nail is used in most light wood frame construction.



c. Screws. Screws are more expensive in time and money than nails, but sometimes are necessary for superior results. They provide more holding power than nails, can be easily tightened to draw the material securely together, are neater in appearance, and may be withdrawn without damaging the material.

(1) Wood Screws. Wood screws are designated according to their head style. The most common type are flathead, oval head, and roundhead with either slotted or Phillips heads.

(2) Lag Screws. They are longer and heavier than the common wood screw and have coarser threads, which extend from a cone or gimlet point slightly more than half the length of the screw. Square-head and hexagon-head lag screws are usually placed with a wrench.

(3) Bolts. Bolts (sometimes referred to as lag bolts) are used when great strength is required or when the work must be frequently disassembled

(4) Expansion Shields. Expansion shields are inserted in pre-drilled holes, usually masonry, to provide a gripping base or anchor for a screw, lag bolt, or nail.

(5) Drift Pins. Drift pins (called drift bolts for supply purposes) are long, heavy, thread-less bolts used to hold heavy pieces of lumber/timber together.

(6) Corrugated Fasteners. Corrugated fasteners and metal hangers are used to fasten joints and splices in small timber and boards.

(7) Timber Connectors. Timber connectors are metal devices for increasing the joint strength in timber structures.

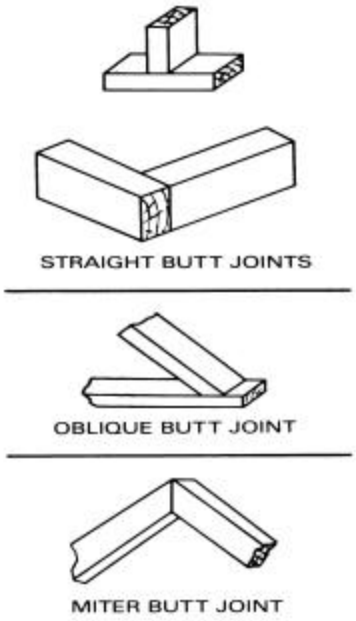
12. JOINTS AND SPLICES

a. Joints. Joints are connections between two pieces of timber, which come together at various angles.

(1) Straight Butt Joint. Form the straight butt joint by bringing the square-cut end of one board against the square face of another. The butt end of one board should be square and the face of the other smooth so that the pieces fit perpendicular to each other. This is the most common joint used in wood frame construction.

(2) Oblique Butt Joint. Form the oblique butt joint by bringing the end of one board, cut to form the desired angle, against the face of another board with which it is to be joined. Bracing is a typical application for this joint. Do not use this joint where great strength is required.

(3) Miter Butt Joint. Form the miter butt joint by bringing the mitered ends of two boards together to form a desired angle. To form a right-angle miter joint (the most commonly used miter joint), cut each piece at a 45-degree angle so that when the pieces are joined they form a 90-degree angle. The miter joint is a very weak joint and is not to be used where strength is important.



(4) Plain Lap Joint. Form the plain lap joint by laying one board over another and securing the two by means of screws or nails. This joint is as strong as the fasteners and material used.

(5) Half-lap Splice Joint. Construct this splice by cutting away portions (usually half) in equal lengths from the thickness of two boards and joining them in such a way that the cutaway portions overlap to form the joint. Overlapping surfaces must fit snugly and smoothly.

b. Splices. Splices connect two or more pieces of timber together so they will be as strong as a single timber of the same length and the joint will be as strong as the disconnected portions.

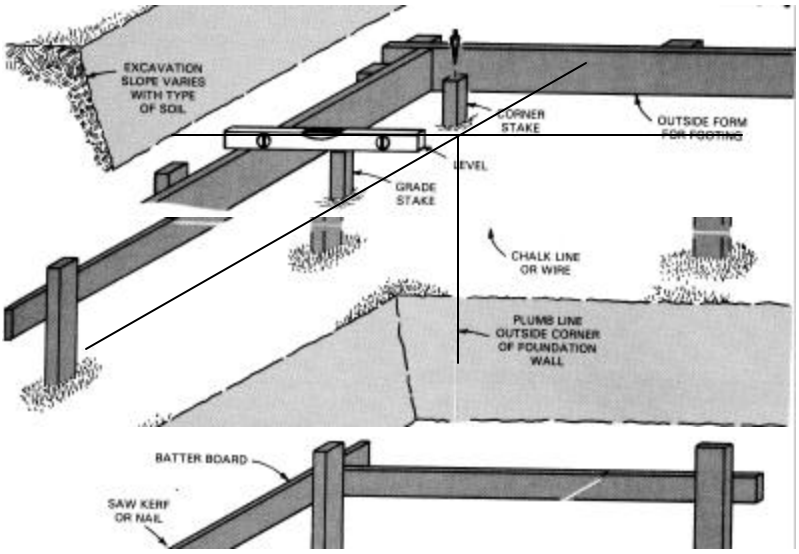
(1) Butt Splice. Construct the butt splice by butting the squared ends of two pieces of timber together and securing them in this position by means of two wood pieces (scabbing) fastened on opposite sides of the timber. When nails are used with scabs, stagger them and drive them in at an angle away from the splice. Too many nails, or nails that are too large, will weaken the splice.

(2) Halved Splice. Construct the halved splice by cutting away half the thickness of equal lengths from the ends of two pieces of timber and fitting the complimentary tongues or laps together. The laps should be long enough to have sufficient load bearing surface.

13. BUILDING LAYOUT

a. Building layout is the action performed to prepare the material and work area before beginning construction.

b. During the layout, the exact location and outside dimensions must be Established. Surveyors using an engineer transit can accomplish this.



c. Another method used by combat engineers is using Batter Boards this is a simple method using wood stakes, boards and string to identify the outside dimensions of the structure to be built. They are constructed using 2x4 stakes, with 1x3 boards nailed to them, to which a string is attached, as shown below

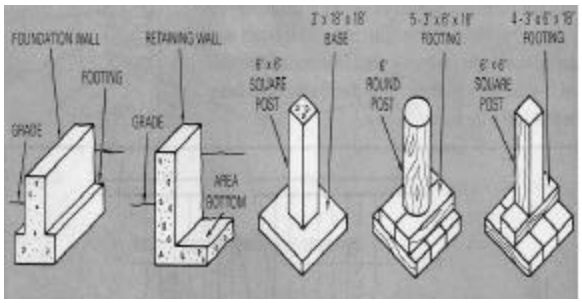
(1) The Batter boards must be Square, level, and straight. There are two methods to accomplish this:

(a) 3-4-5 Method: Using a Carpenters Square at the intersection of your sting lines. You measure three inches down from the corner on one line and 4 inches down the other line. Then measure the distance between these two Marks should be 5 inches.

(b) Diagonal Method: Measuring from one corner to the opposite corner, do the same between the other two corners and ensuring that the distance is the same between them.

14. FOUNDATION

a. The construction of any building must start with a foundation. Foundations may be constructed of cut stone, rock, brick, tile, wood, or concrete. The material used will depend on the type of structure, the availability of material, and the amount of weight it must support. An inadequate foundation will result in uneven settling, and may cause cracked plaster, ill-fitted doors, or sticking windows. There are several types of foundations.

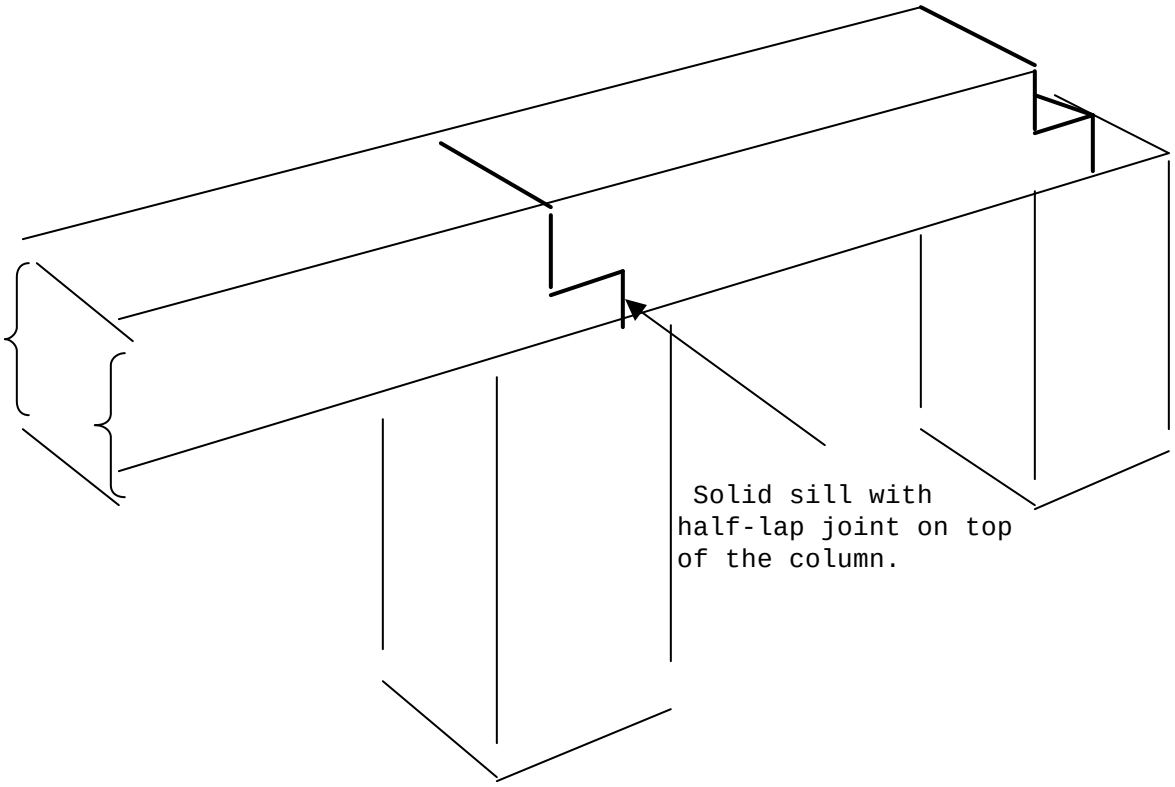


(2) Columns or piers are used on construction of a temporary nature. The use of these foundations saves time, labor, and material. They are spaced according to the amount of weight to be carried. The spacing is generally from 6 to 10 feet.

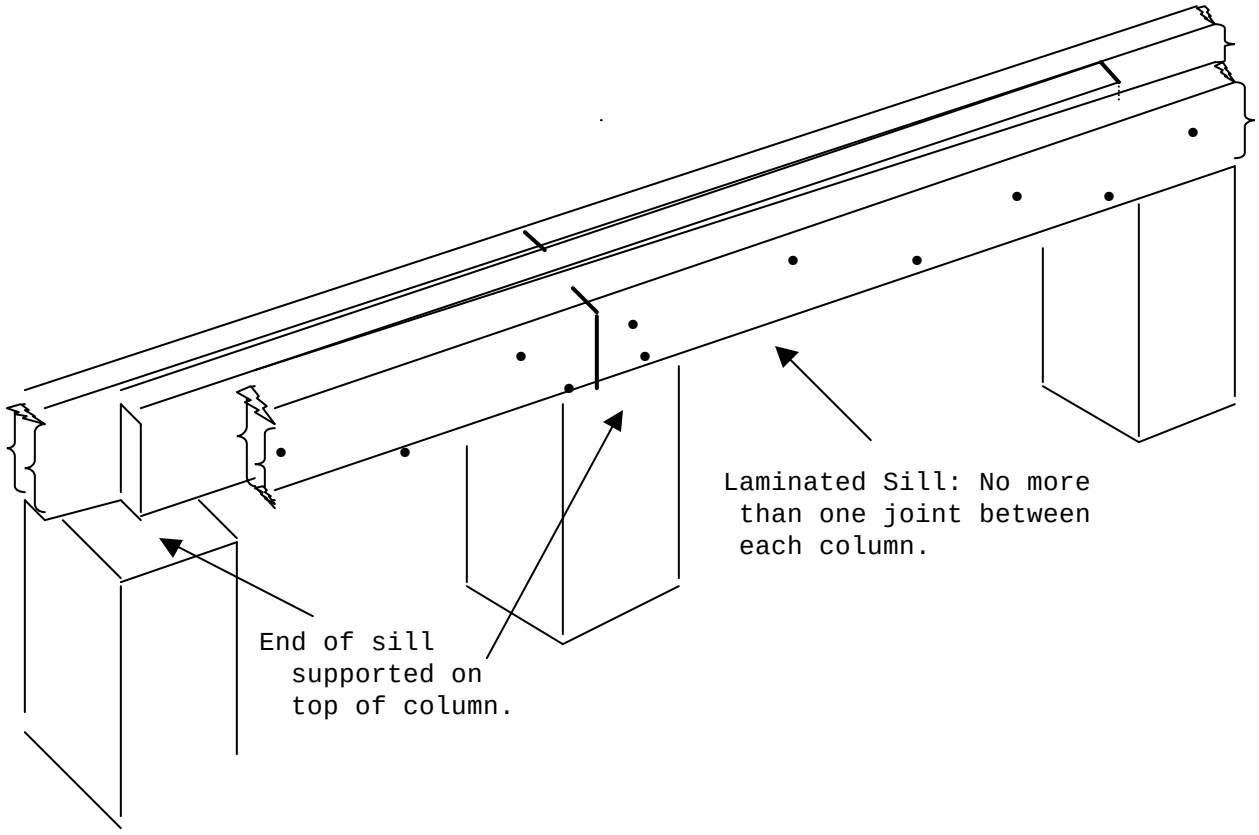
(3) Continuous mud sill consists of material laid directly on the ground. This type of foundation is used often in the field for the construction of strong backs.

15. FLOOR FRAMES AND FLOOR COVERINGS

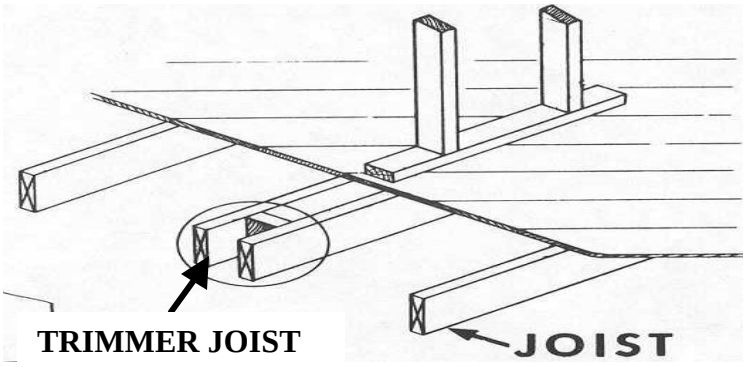
a. Sills. The sill is the base that supports all the building above it. It is the first part of the building to be set in place. It rests directly on the foundation piers or on the ground; it is joined at the corners and spliced when necessary. Sills are fastened to the foundation and provide a nailing surface for the remainder of the framing.



NOTE: Designed for column and pier foundations. It consists of two or more pieces of lumber nailed together, with 16d or 20d nails, to meet the required dimension. The laminated material is laid on edge the length of the building.

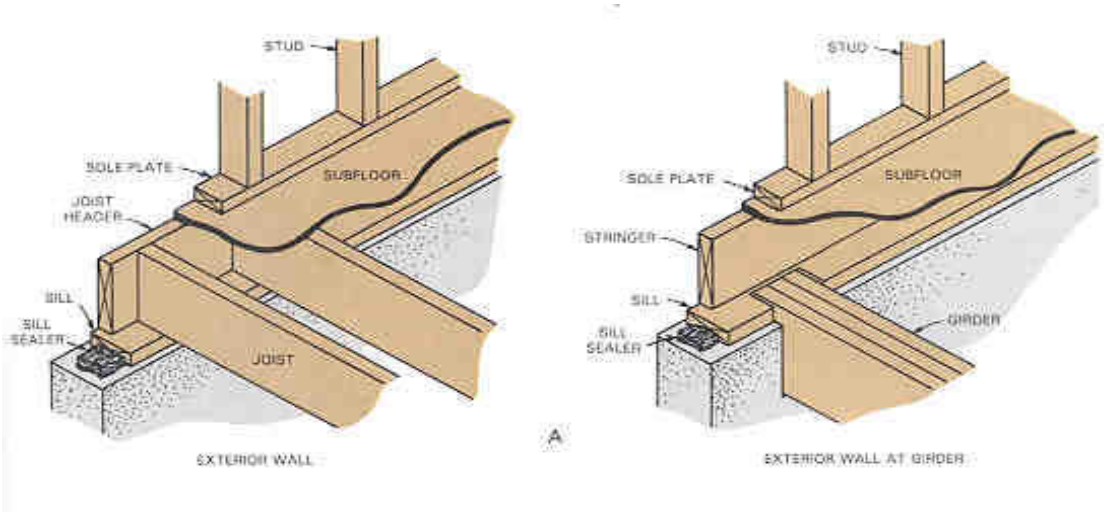


b. Floor Joists. Joists are the wooden members that make up the body of the floor frame. The flooring or subfloor is nailed to them. They are usually two to three inches thick. Joists are normally spaced 16 or 24 inches apart, center to center.



c. Girders. The distance between two outside walls is often too great to be spanned by a single joist. When two or more joists are needed to cover the span, provide intermediate support for inboard joist-ends by one or more girders. A girder is a large beam that supports other smaller beams or joists. A girder may be made up of several beams nailed together with 16d

common nails; or may be solid wood, steel, reinforced concrete, or a combination of these materials.



(1) Connecting joists.

(a) Joists to Sills. When joining joists to sills, be sure that the connection is able to hold the load that the joists will carry.

(b) Joists to Girders. When joining joists to girders, the joists must be level. If the girder is not the same height as the sill, notch the joists.

1 Lap Joint. Set the joist, on edge, on top of the sill or girder.

2 Ledger Plates. When connecting joists to girders and sills when piers are used, nail a 2x4 to the face of the sill or girder, flush with the bottom edge. This is called a ledger plate.

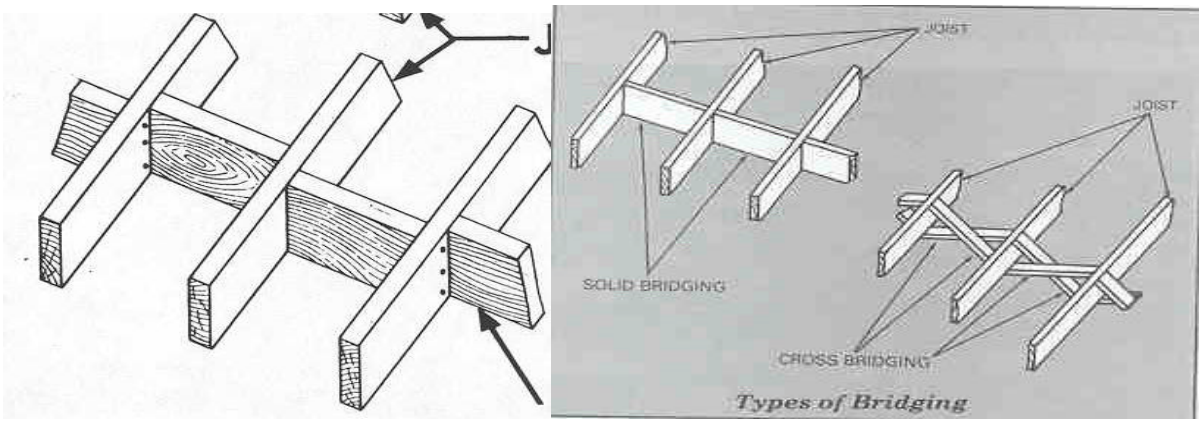
3 Iron Stirrups. One of the strongest supports for the joists is straps or hangers.

(2) When placing joists, always have the crown up since this counteracts the weight on the joist; in most cases there will be no sag below a straight line.

d. Bridging. When joists are used over a long span, they have a tendency to sway from side to side. Therefore, add bridging to stiffen the joist and tie the joists together and prevent twisting. There are several types of bridging.

(1) Horizontal Bridging. Using the same size lumber as the joists, place the bridging between the joists perpendicular to them, thus connecting the joists.

(2) Cross bridging. Cross bridging looks like a (X) and consists of pieces of lumber, usually 1 by 3 or 2 by 3 inches in size, cut and placed diagonally between the floor joists.



(3) When nailing the bridging, nail the tops of the bridging first. **Do not nail the bottoms until the subfloor is laid.** This will give the joists time to adjust to their final position.

e. Subfloors and Finish Floors

(1) Subfloors. Plywood is generally used for interior floors making sure to stagger the seams. Exterior subfloors usually consist of decking boards and are laid diagonally on the joists and nailed with either 8d to 10d nails. Sub flooring boards eight inches wide or over should have three or more nails per joist.

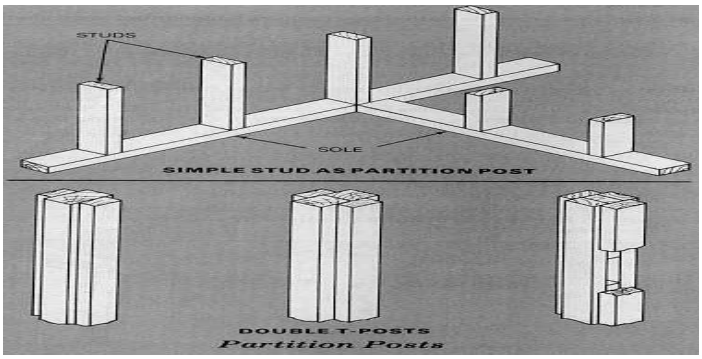
(2) Finish floors. A finish floor is laid if tile or linoleum is used as interior floor covering and in most cases is of 1/4 to 1/2 inch plywood. It is laid directly on the subfloor and glued or nailed with 6d finish nails. When laid on a subfloor, it is best to use a moisture barrier between the two floors to keep out dampness and insects. In warehouses, where heavy loads are to be carried on the floor, use two-inch material.

16. WALLS AND WALL COVERINGS

(a) Wall Components

(1) Sole Plate. The sole plate is a horizontal piece of lumber that is laid directly on the joists or the floor. It carries the bottom end of the studs. Nail the sole plate at each joist it crosses.

(2) Studs. Studs are the vertical pieces of lumber that rest on the sole plate. Studs are normally spaced 12, 16, and 24 inches on center, depending upon the type of outside and inside finish.



(3) Top Plate. The top plate ties the studding together at the top and forms a finish for the walls; it furnishes a support for the lower ends of the rafters. Double the top plates when they are used on bearing walls and partitions.

(4) Partitions. Partition walls divide the inside space of a building. There are two types of partitions.

(a) Bearing partitions help support ceiling joists.

(b) Nonbearing partitions support nothing but themselves.

(5) Corner Posts. The studs used at the corners of a frame construction are usually built up from three or more ordinary studs laminated together to provide greater strength.

(6) T-Posts. Use a T- post whenever a partition meets an outside wall. It consists of a stud wide enough to extend beyond the width of the partition on both sides.

(6) Partition and Double T-Posts. Where a partition is finished on one side only, use a partition consisting of a simple stud, set in the outside wall, in line with the side of the partition wall, and finished as a stud. Nail the posts in place along with the corner post. Where partition walls cross, use a double T- post.

(7) Bridging. Wall frames are normally bridged to make them sturdier. There are two types of bridging.

(a) Diagonal Bridging. Nail diagonal bridging between the studs at an angle.

(b) Horizontal Bridging. Nail horizontal bridging between the studs horizontally and halfway between the sole plate and top plate.

(8) Braces. Bracing is used to stiffen framed construction and make it rigid Bracing may be used to resist winds, storms, twisting or strain stemming from any cause. There are three methods commonly used to brace frame structures.

(a) Let-in Bracing. This type of bracing is set into the edges of studs and flush with the surface. The studs are always cut to let in the braces; the braces are never cut. Usually 1" x 4" or 1" x 6" are used, set diagonally from top plates to sole plates.

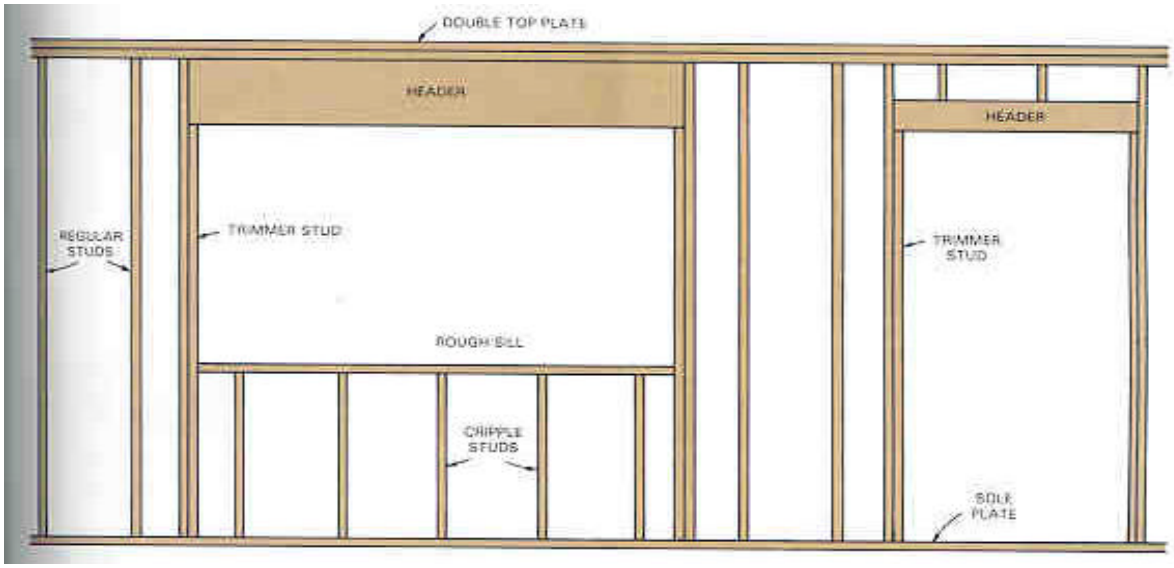
(b) Cut-in Bracing. This type of bracing is toe nailed between the studs. It usually consists of 2" x 4" cut at an angle to permit toe nailing which are inserted in diagonal progression between studs running up and down from corner post to the sill or sole plates.

(c) Metal Bracing. This type of bracing is used when plywood is not used for exterior sheathing. It is placed on all corners diagonally and in a form of a (X) throughout the center of the walls. The bracing is nailed to each stud that is crossed from the double top plate to the sole plate.

(d) Plywood Sheathing. This is the strongest type of bracing. It is placed at all four corners of the structure and acts as a brace since it is nailed into each stud. **If plywood sheathing 5/8 inches or more is used, other methods of bracing may be omitted.**

(9) Exterior Walls. Exterior surfaces of a building usually consist of vertical, horizontal, or diagonal sheathing. Nail sheathing directly to the framework of the building. Its purpose is to strengthen the building and to provide a base wall onto which the finish siding can be nailed.

(10) Interior Walls. Interior walls and partition coverings are divided into the general types, wet wall material, generally plaster; and dry wall material including wood, plasterboard, plywood, and fiberboard.



(11) Door Frames. Before placing the exterior covering on the outside walls, prepare the door openings for the frames. Rough openings are usually made two and a half inches larger each way than the size of the door

to be hung. Add an extra stud to each side of the door opening and place a header on top.

(12) Windows. Windows are generally classed as sliding, double hung, and casement. All windows, whatever the type, consist essentially of two parts, the frame and sash. The frame is made up of four basic parts: the header, two jambs, and the sill. The sash is the framework that holds the glass in the window.

(13) Other wall openings. Wall openings other than door and windows are ones that have stove pipes, ventilators, vents, or crawl spaces, and should not be put in places that you have to cut through studs, plates, or bracing.

17. ROOFS AND COVERINGS

a. Types of Roofs.

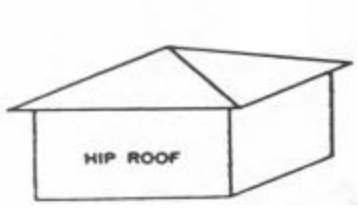
(1) Lean-to or Shed Roof. This nearly flat roof is used where large buildings are framed under one roof. It may also be used where hasty or temporary construction is needed, and where sheds and additions to buildings are erected. The slope of this roof is one direction.

LEAN-TO or SHED ROOF

GABLE ROOF

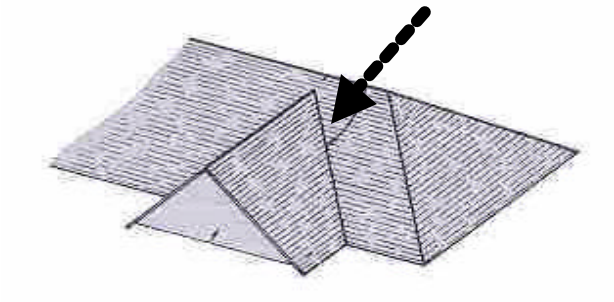
(2) Gable Roofs. This roof has two roof slopes that meet at the center, or ridge, forming a gable. It is the most common roof because it is simple and economical, and may be used on any type of structure.

(3) Hip Roof. This roof has four sides or slopes running towards the middle of the building.



(4) Gable and Valley Roof. This roof is formed by two intersecting gable roofs, which meet at a valley. Each roof slants in a different direction. This roof is seldom used, since it is complicated and requires much time and labor.

Gable and Valley Roof



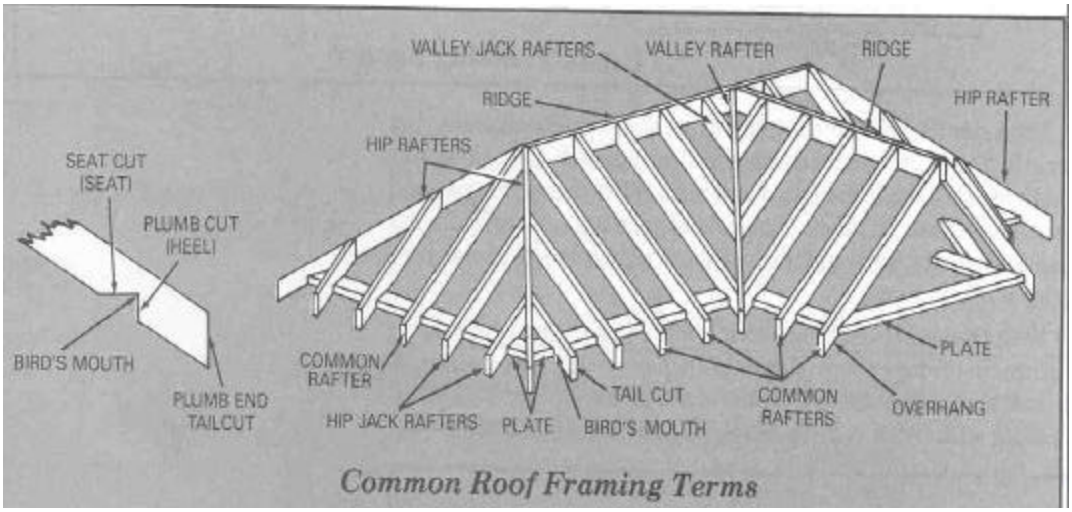
b. Components

(1) Ceiling joists form the framework of a room. They are usually lighter than floor joists, but must be strong enough to resist buckling or bending. Ceiling joists starts at one side of the building and continues across, parallel to the rafters.

(2) Ridge (Ridge Board). The ridge is the highest horizontal framing member, which helps align the rafters and tie them together at the upper end.

(3) Rafters. Rafters make up the main body of the framework of roofs. They do for a roof what the floor joists and studs do for the walls.

(a) Types of rafters:



1 Common Rafters. Common rafters are the framing members that extend at right angles from the plate line to the ridge of the roof. They are called common rafters because they are common to all types of roofs and used as the basic for laying out rafters.

2 Hip rafters are roof members that extend diagonally from the corner of the top plate to the ridge board.

3 Valley rafters extend from to top plate to the ridge boards along the lines where the two gable roofs intersect.

4 Jack rafters

a Hip jack rafters extend from the top plate to the hip rafter.

b Valley jack rafters extend from the ridge board to the valley rafter.

c Cripple jack rafters are placed between a hip and valley rafter.

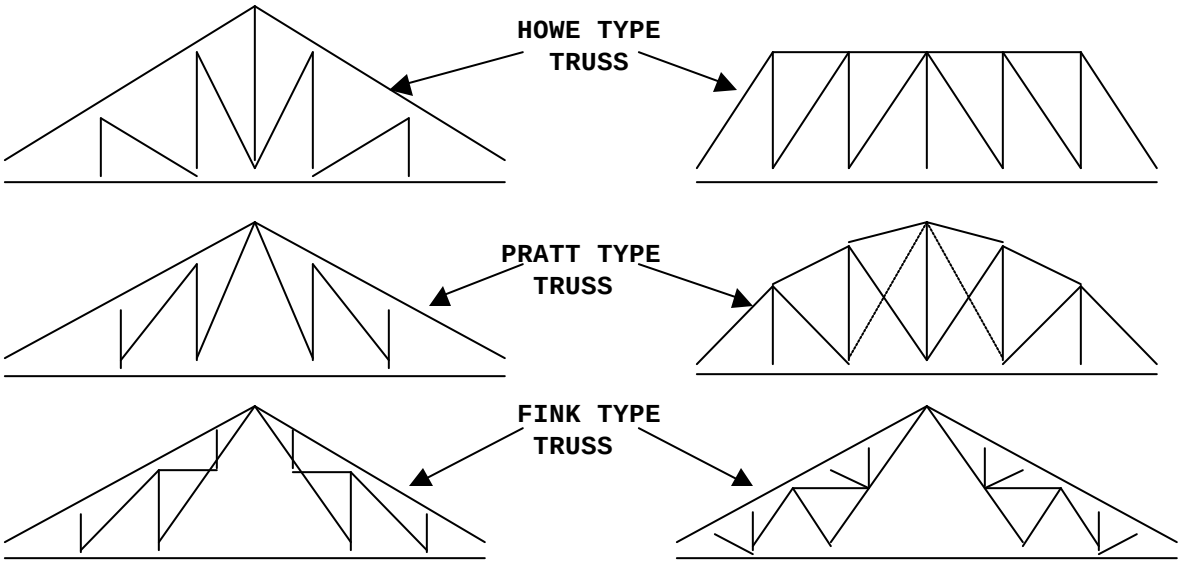
(4) Pitch of the roof is the angle of the roof slope in relation to the horizontal plane. This is measured as a ratio, i.e. 4/12, 5/12.

(5) Bird's mouth is a cutout, near the bottom of the rafter that fits over the plate.

(6) Overhang is the portion of the roof, which extends beyond the outside edge of the plate or walls of a building. The overhang is often referred to as the lookout, eve, or tailpiece.

(7) Truss construction. Reinforced rafters where large spans provide wide unobstructed floor space.

(a) Types of trusses. Details for trusses are usually found in the "detail drawings" of blueprints.



(b) Rafters for truss construction are laid out the same as a common rafter except no shortening allowance, as there is no ridge board.

(c) Upper and lower chord

1 Ties the rafter and distributes the weight.

2 Lower chord becomes ceiling joist.

3 May be one piece or jointed, stagger the joints.

(d) Diagonal brace

1 Ties the upper and lower chord together and helps distribute the weight.

2 General rule for braces: 15 - 25 degrees.

(e) Cut all pieces from one pattern and make a jig.

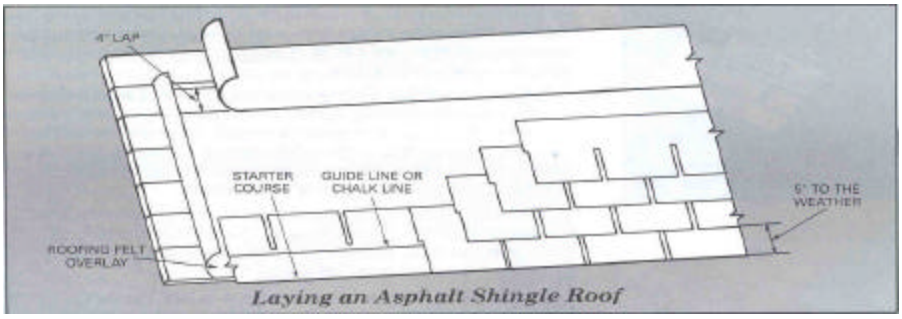
(f) Hand or power (crane, gin pole, block and tackle) may erect trusses.

(8) Roof Coverings. Asphalt roofing products are widely used in modern construction; the components of roof coverings are as follows:

(a) Roof Sheathing. Roof sheathing should be smooth, dry and securely attached to the rafters or ridge board. The roof sheathing must provide an adequate base to receive and hold the roofing nails or fasteners, 1/2, 5/8, or 3/4" plywood adequate enough as a nailing surface.

(b) Flashing. This is placed between roof sheathing and roof underlay in places especially vulnerable to leakage and must be watertight.

(c) Roofing Underlay. Roofing underlay is made of roofing felt and is placed over the secured roof sheathing. Roofing felt or underlay comes in rolls 36" wide and should be laid with a 4" lap. Felt paper is laid for extra protection. A roll usually covers 400 or 500 sqft. The felt or tar paper is rated by weight, 15-50 Lbs according to it's thickness.



Laying an Asphalt Shingle Roof

(d) Asphalt Roofing Singles. The most commonly used, is the flat strip, they must be weather resistant they are 1' x 3'. Their base material is organic felt and/or fiberglass. This base is saturated and then coated with a special asphalt that is resistant to weathering. A surface of ceramic-coated mineral granules is than applied. The mineral granules shield the asphalt coating from the sun's rays, add color, and provide fire resistance.

1 Laying of Asphalt Roofing Singles. Each row of singles is called a course. The first course at the eaves is the starter course and is laid by inverting the first course of shingles. Each course after the (the starter course), is laid by stretching a guideline or snapping a chalk line from edge to edge of the roof (**this positions the course**) and the singles follows the chalk line. The above shows the method of laying a 1'x 3' asphalt strip shingle roof.

2 Nailing Pattern. Strip shingle should be nailed with a 1-inch copper or hot dipped galvanized roofing nails, two to each tab; this means six nails to each full strip. Nails should be placed about 6 ½ inches from the butt edges to insure that each nail will be covered by the next course (blind nailing) and driven through two courses. There should be no more than ¾ inch over hang all the way around the roof.

REFERENCES

1. FM 5-461, Engineer Hand Tools

2. FM 5-426, Carpentry